

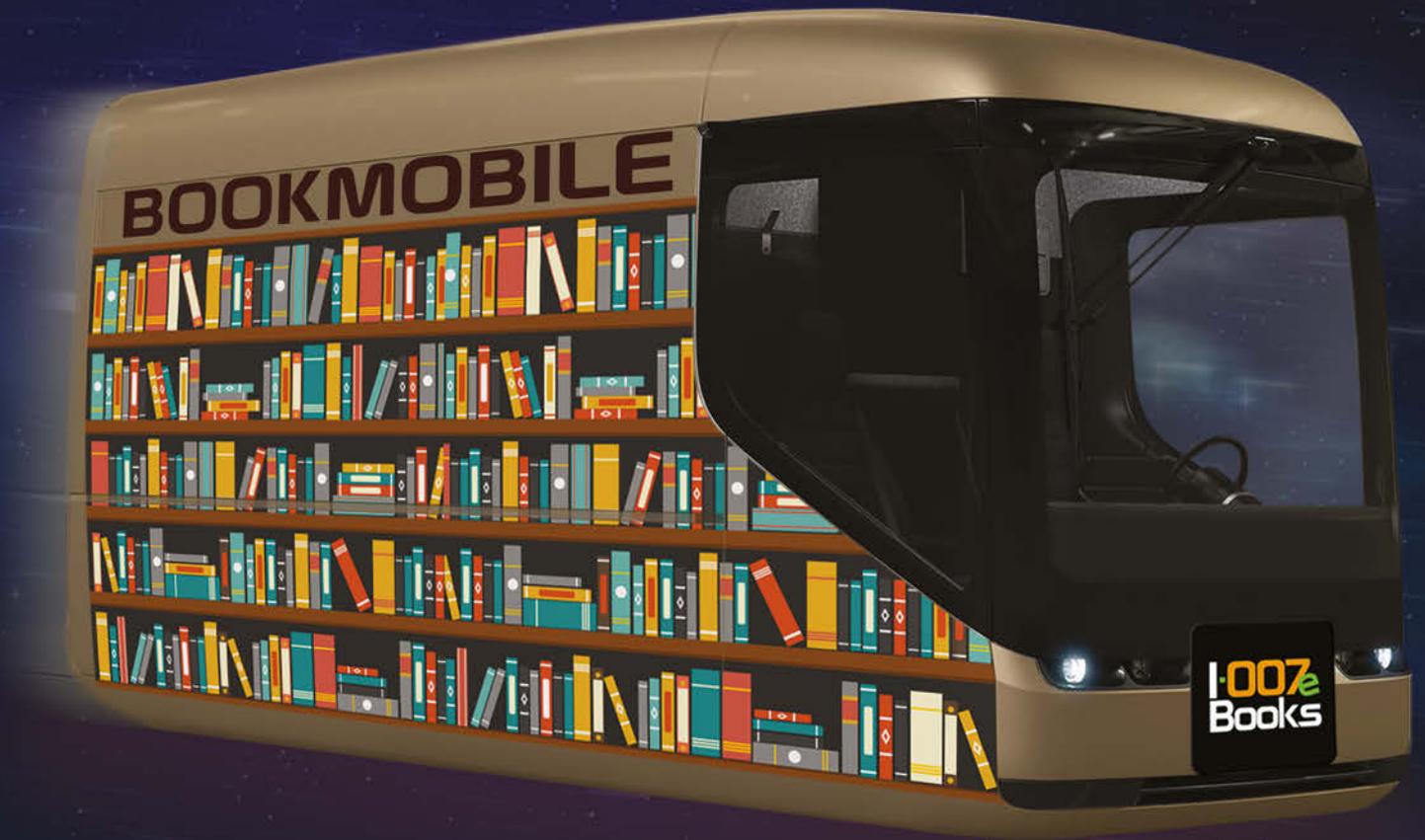
IConnect007

JANUARY 2019

SMT007

M A G A Z I N E

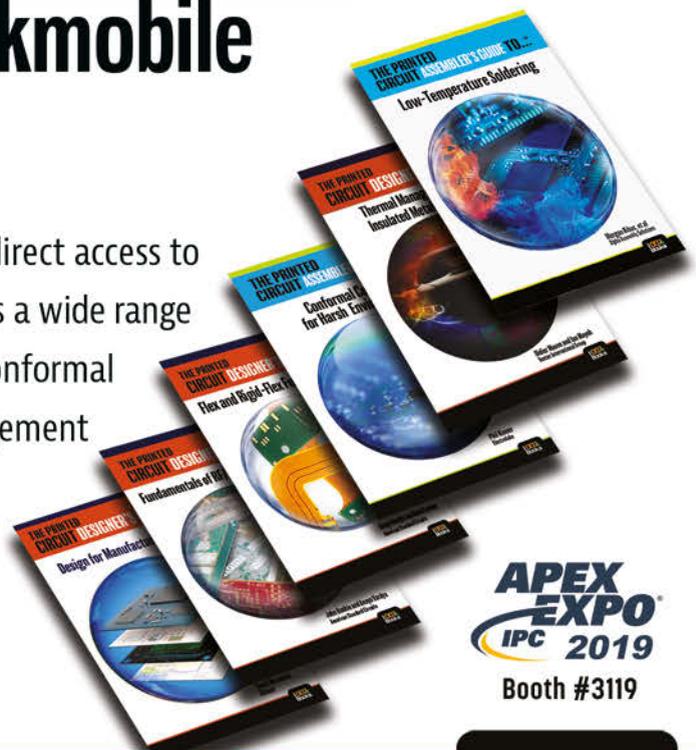
**Supply Chain
Issues
Keeping YOU
Up at Night?**



Our library is the bookmobile for the 21st century

Registered members of **my I-Connect007** have direct access to our ever-growing library of eBooks, which includes a wide range of topics, from low-temperature soldering and conformal coating in harsh environments to thermal management and data package perfection. Registered users simply download new titles free with the click of a mouse. It's pretty awesome!

I-007eBooks.com



APEX EXPO
IPC 2019
Booth #3119

my I-Connect007
GOOD FOR THE INDUSTRY

I-007e
Books

The universe is a harsh place.

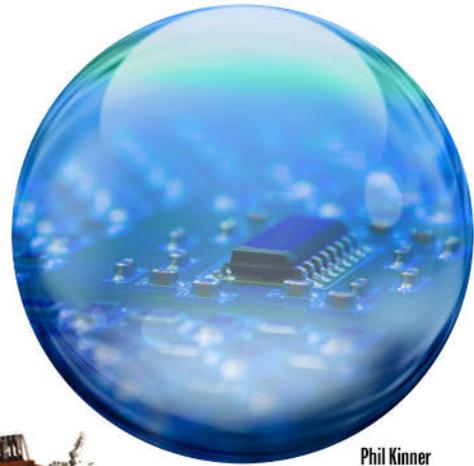
Here's how you can protect critical components that operate in adverse environments.

Written by Phil Kinner of Electrolube's Conformal Coatings Division, this book simplifies the many available material types and application methods, and explains the advantages and disadvantages of each.

[Download Now](#)

THE PRINTED
CIRCUIT ASSEMBLER'S GUIDE TO...

Conformal Coatings
for Harsh Environments



Phil Kinner
Electrolube

100%
Books

1007e
Books

SMT007

M A G A Z I N E

Supply Chain in Crisis

Component supplies, prices, and lead times are in a great deal of turmoil. And there are a LOT of moving parts to this set of circumstances, ranging from a sustained increase in demand for parts, to pricing pressures on manufacturers and premature parts obsolescence. All of these factors wreak havoc on electronics manufacturing. In this issue, we explore the drivers and the coping mechanisms from all points of the supply chain.



12 The Electronic Component Shortage Crisis: A Veteran Engineer's Perspective
by John Watson



20 Digi-Key's Dave Doherty: Tweaking the Supply Chain
by Nolan Johnson and Andy Shaughnessy

30 Dan Schoenfelder: Searching for Parts in Real Time
by the I-Connect007 Editorial Team

40 Stephanie Martin: Component Supply Challenges From the Catbird Seat
by the I-Connect007 Editorial Team

54 Sunstones's Matt Stevenson on Supply Chain Issues in Quick-turn Fabrication
by Barry Matties and Nolan Johnson

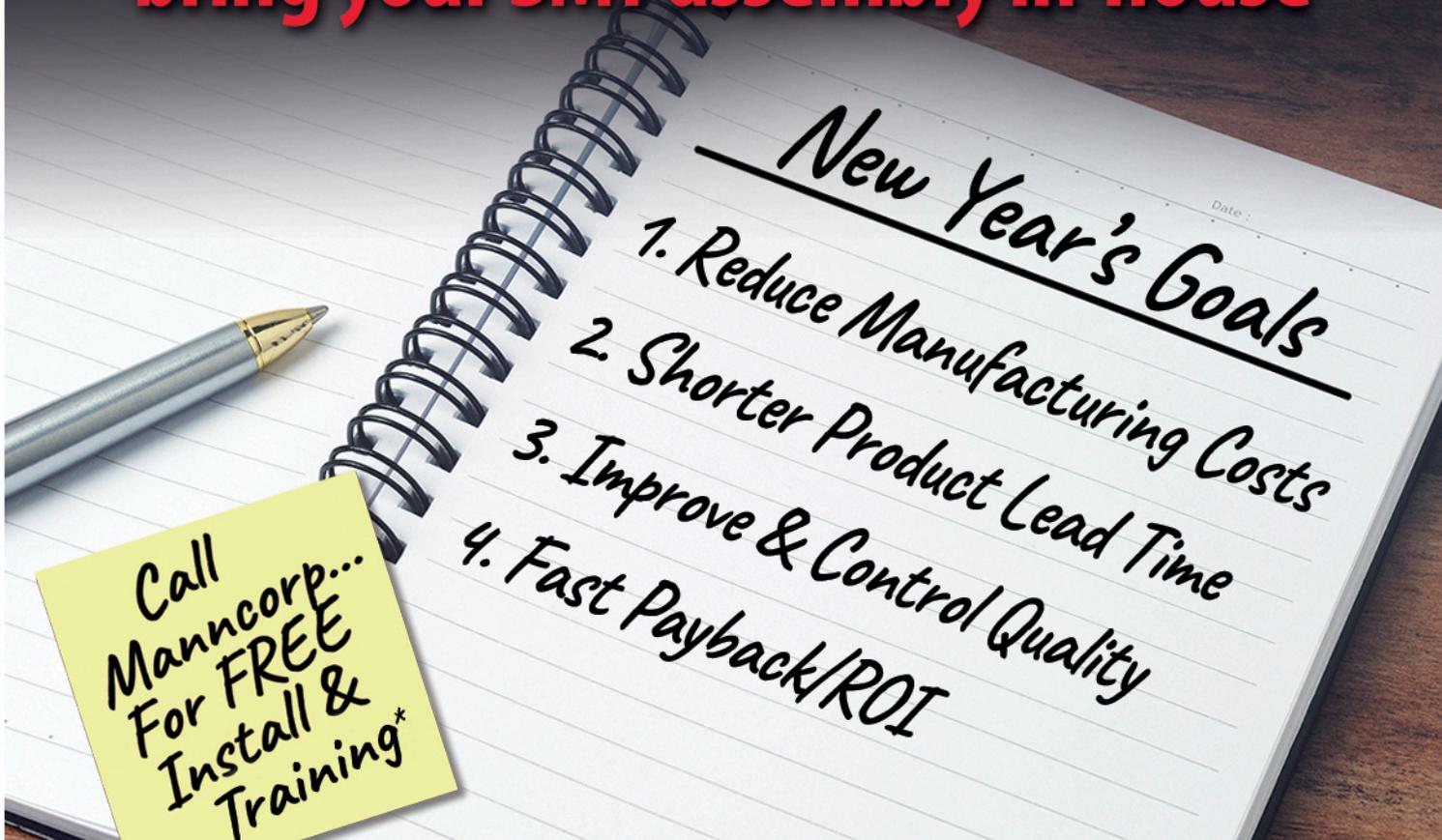


64 No Rest for the Weary: Supply Chain Pressures Are Here to Stay!
by Jamey Mann

70 Natasha Baker: Supply Chain Transparency Inside the CAD Tool
by Nolan Johnson



Start the new year off right... bring your SMT assembly in-house



Take advantage of this great New Year's deal from Manncorp. Not only will you receive a free evaluation of your manufacturing needs, you'll also benefit from expert installation and training services completely FREE of charge. Come out and visit our booth at APEX or see us in our San Diego demonstration center to see everything that we can do for you.



AP430 Stencil Printer



MC-389 Pick & Place



CT90 Conveyor



CR-5000 Reflow

*US & Canada through February 28, 2019

Text or Call

Chris - East: 215.869.8374

Ed - West: 215.808.6266

ManncorpTM
www.manncorp.com

Huntingdon Valley, PA • San Diego, CA

**APEX
EXPO**
IPC 2019
BOOTH #1151

Email

sales@manncorp.com



© 2019 by Manncorp

SMT007

M A G A Z I N E

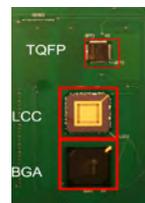


SHORTS:

- 19** What Is Your Supply Chain Telling You About Components?
- 52** Electrolube on Managing Thermal Interfaces and Conformal Coatings
- 62** Dr. Traian Cucu Discusses Low-temperature and Lead-free Soldering
- 68** Artificial Muscle Takes Origami to the Next Level
- 74** How to Avoid Supply Chain Disruption this Chinese New Year

COLUMNS:

- 8** Supply Chain in Crisis
by Nolan Johnson
- 78** The Effect of Thermal Profiles on Cleanliness and Electrical Performance
by Eric Camden
- 90** How Much is Too Much?
by Bob Wettermann
- 94** The Fourth Pillar of Defense Acquisition: Cybersecurity
by John Vaughan



HIGHLIGHTS:

- 38** Market
- 76** MilAero007
- 88** Supplier
- 100** Top Ten from SMT007.com



DEPARTMENTS:

- 103** Career Opportunities
- 110** Events Calendar
- 111** Advertiser Index & Masthead





BLACKFOX

Premier Training & Certification



Experience the Blackfox Difference!

Premier IPC Training & Certification

- High quality training and customer service
- Offering 6 certification programs in four locations
- *Colorado, Arizona, Mexico, Malaysia*
- Military Veterans Advanced Manufacturing Program
- **NEW!** IPC/WHMA-A-620 Space Addendum for trainers and specialists
- Online store supporting the training industry



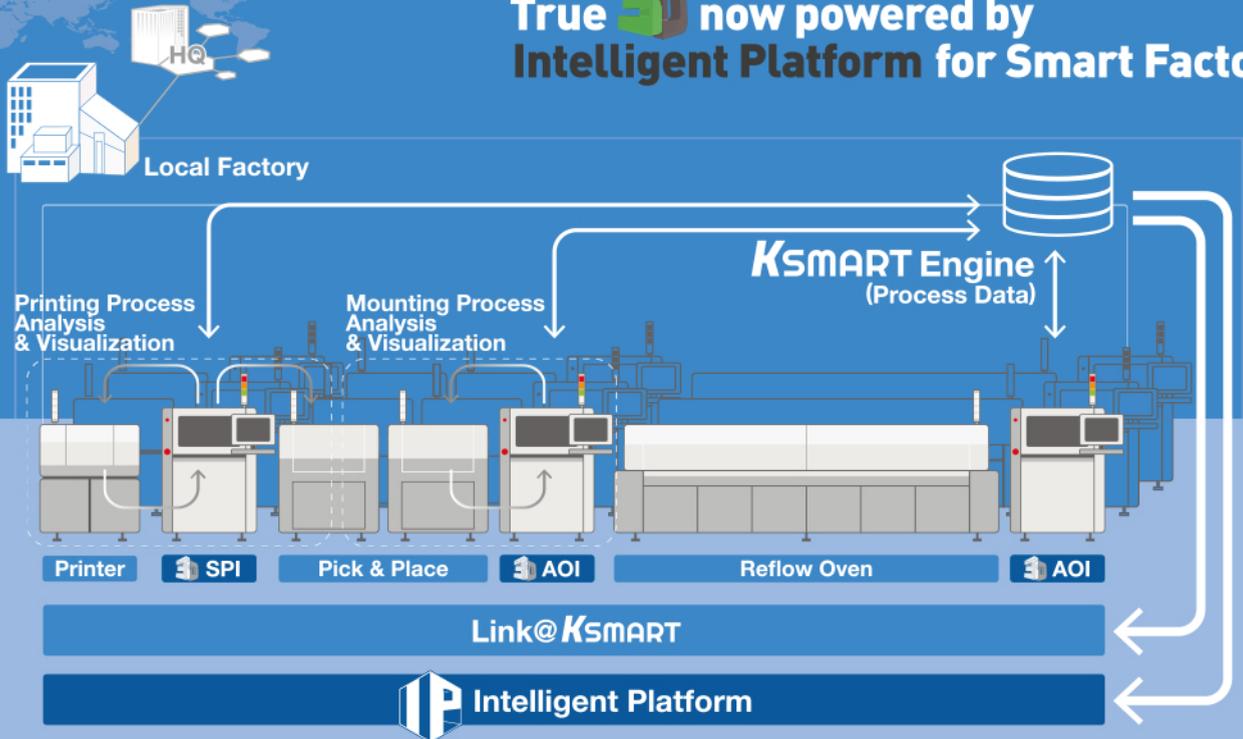
[CLICK FOR COURSE SCHEDULE](#)

For more information contact us at
888.837.9959 or sharonm@blackfox.com

www.blackfox.com



True 3D now powered by Intelligent Platform for Smart Factory



**World's No.1 Inspection Company,
now powered by Intelligent Platform
from Programming to Optimization**

World's Fastest True 3D AOI

World's Best Performance 3D SPI



ASPIRE3

-  Ultra High Inspection Speed
-  Complete Process Solutions
-  Highest Accuracy

ZENITH UHS
Ultra High-Speed

-  Ultra High Inspection Speed
-  Perfect True 3D Inspection Performance
-  3D Data based SMT process Control System



**APEX
EXPO**
IPC 2019

Booth 1908

Koh Young America, Inc.

6150 W. Chandler Blvd., Suite 39, Chandler, AZ 85226
Tel: +1-480-403-5000, E-mail: america@kohyoung.com

www.kohyoung.com

The repercussions ripple up and down the supply chain at will.

To stay competitive and create long-lived products, design teams need to improve their component selections—and their design skill sets in some cases—to use the parts that will be available long term. They need to pay attention to parts availability in the short term too. It may begin with the designers—and the designers certainly end up being held accountable to updating the design to keep the product current—but it takes the entire supply chain being in communication to keep everyone informed and in production.

As you will see from this issue, there are a LOT of moving parts to this set of circumstances. While the general consensus is that this is not just a radar blip in the supply chain, there will be relief. Approach these challenges with the right attitude and learn from the experiences of others under the same constraints, and when the relief comes, we'll all be better and more flexible designers with some new traditional behaviors.

We kick it off with John Watson's article outlining "A Veteran Engineer's Perspective" on the current market. John delivers a great overview of a serious situation without losing his sense of humor in the process.

Next, Andy Shaughnessy and I talk to Digi-Key COO, Dave Doherty, about the careful, small adjustments being made to improve the current shortages. Dave's insight is valuable to contract manufacturers and designing customers alike.

Speaking of designing customers, the I-Connect007 editorial team explored the value of incorporating parts availability, performance characteristics, and design tool parts definitions with Octopart's Dan Schoenfelder.

Stephanie Martin, senior VP of supply chain at Vexos, also spoke with the I-Connect007 editorial team on the root causes of the supply chain situation and how to adapt.

PCB fabrication is a critical step in this process, and Sunstone Circuits' Matt Stevenson gives his insights to help us gauge the impact all this is having on the board fabrication business.

In his article "No Rest for the Weary: Supply Chain Pressures Are Here to Stay," Jamey Mann walks us through current best practices for ensuring a steady supply of critical parts during these times of uncertain supply.

Next, Natasha Baker, SnapEDA CEO, discusses how her company's dynamic parts library for design tools can help identify supply issues while designing.

In his column "Knocking Down the Bone Pile," Bob Wettermann considers the question, "How much is too much?" with respect to heating and cooling cycle limits on PCBs during both the manufacturing and potential rework phases. Given the changing dynamics of the supply chain calculus, rework comes once again to the fore.

This month, Eric Camden devotes his column to "The Effect of Thermal Profiles on Cleanliness and Electrical Performance." He submitted a paper to the SMTA International 2014 proceedings, and the topic continues to be timely. Eric refreshes that paper and continues the discussion.

Finally, John Vaughan's column, "The Fourth Pillar of Defense Acquisition: Cybersecurity," puts yet another variable into play for the supply chain crisis—the security of the data as it moves through the chain of manufacturing. Quoting John's column here, "In today's digitized world, every one of these [infinite number of] supply chain touch points represents a potential product security risk."

After researching and conducting numerous interviews, it would seem that the dynamics and root causes of this crisis are generally well understood. What is emerging—and disruptive—is the awareness that even when things get better, the "business as usual" we return to will not be exactly the way it was.

No, we'll be doing things differently—and hopefully, better—once this is all over. **SMT007**



Nolan Johnson is managing editor of *SMT007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing. To contact Johnson, [click here](#).



Since we first began in 1985, delivering the highest quality products possible has been our first priority. Our quality control systems are certified and we renew our commitment to quality each and every day.

Delivering quality products on time, combined with timely and accurate communication from our customer service team is how we create lasting relationships with our customers.

Take a look at our quality »

COMMERCIAL • MILITARY • MEDICAL • BAREBOARD



U.S. Circuit, Incorporated
2071 Wineridge Place
Escondido, CA 92029
+1 (760) 489-1413
www.uscircuit.com





By failing to prepare, you are preparing to fail.

— Benjamin Franklin

The Electronic Component Shortage Crisis: A Veteran Engineer's Perspective

Feature by John Watson, CID
BUILDING CONTROL SYSTEMS, LEGRAND INC.

Most of us are familiar with the defense readiness condition (DEFCON) levels. If we could apply such a DEFCON level to the electronics industry and how it relates to the issue of component shortages, we would be sitting at a DEFCON 1, meaning nuclear war is imminent.

This issue has a huge effect on everyone who works in the electronics field, impacting schedules and how things are done. The problem began to hit in earnest about a year ago in 2017. It first appeared as longer lead times on multilayer ceramic capacitors (MLCCs) and tantalum capacitors. With longer lead times, the available stock began to disappear, and before we knew it, we had a perfect storm and an international crisis.

From where we stand now, at the beginning of 2019, we see lead times for some components

in the short range of up to 16 weeks; medium-to-high is 32 weeks, and long lead times are as far out as 80 weeks. In other words, if we ordered a component today, it would arrive in over a year a half from now (maybe).

This all started with the capacitors (we will see why later), but we now see other component series being sucked into this problem (Figure 1).

With such volatility in the market, it has brought those who were not prepared for it to a standstill.

- Board Mount Temperature Sensors (~ 5 week lead time)
- Power Switch ICs (~6 to 10 week lead time)
- MOSFETs (~26+ week lead time)
- Suppressors/Diodes (~49 week lead time)
- Operational Amplifiers & Relays (~52 week lead time)
- Thick/Thin Film Resistors (~6 to 80 week lead time)

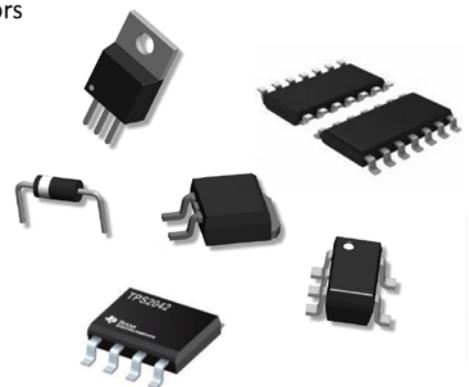
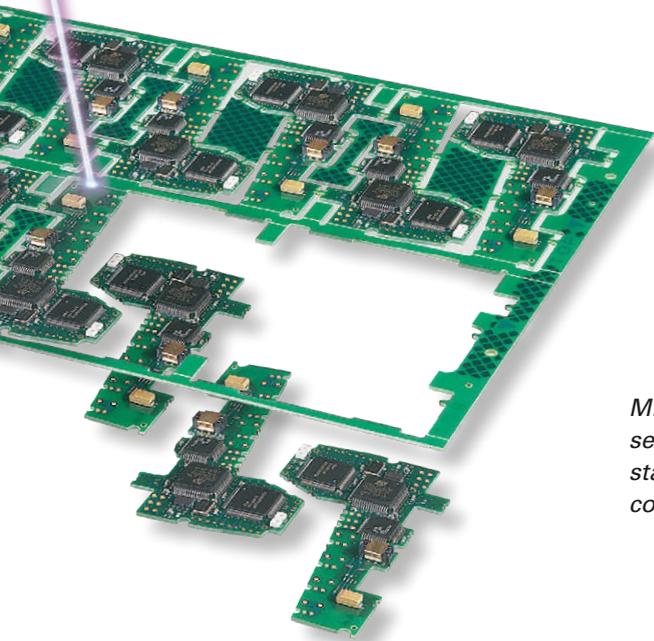


Figure 1: Common parts in short supply, with typical lead times.

M I C R O L I N E 2 0 0 0

Laser Depaneling Systems

- Stress Free, Burr Free, Particle Free
- Low Investment and Operating Cost
- Cuts Flex, Rigid or Rigid-Flex PCBs



MicroLine 2000 series available in stand-alone or in-line configuration

LPKF
Laser & Electronics

LPKF

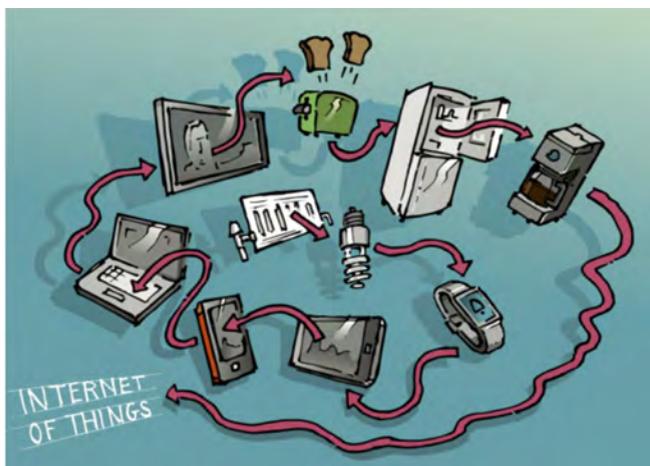
Laser & Electronics

Call us to learn more about laser depaneling.

What Is Driving This Crisis?

It has come down to a simple principle of economics supply and demand. While the supply has gone way down, the demand for many components has exploded. The component manufacturers have not kept pace with the demand for several reasons.

There are three main sectors of the electronic industry driving these component shortages.



1. Internet of Things (IoT)

Demand for smart devices has exploded, ranging from TVs to Bluetooth speaker systems; home devices from Amazon, Google, Apple, and others; renewable energy products; solar panels; and cloud computing. It seems like we now have a “smart” everything!

On the more humorous side, what happens when IoT goes bad? For example, if you go to the refrigerator to add a dozen donuts to your shopping list, and the fridge has been connected to and talking with the scale, does it decide to place you on a diet instead?

According to Gartner, there will be more than 20 billion new IoT devices deployed by 2020, which will be a 100% growth rate in the number of these devices in the next couple of years. That’s a lot of hardware to be placed into the market. It is estimated that there will not be an industry or area of our lives that will not be touched by IoT in some way.

2. Mobile Phone Industry

Personal phone usage has seen a huge increase; it was recently reported to have

doubled since 2015. If you want evidence of this, go to your local mall, sit in the food court, and watch people—everyone is completely engrossed in their mobile device. It is estimated that approximately 1.5 billion smartphones will be manufactured in the upcoming year, and each flagship model contains roughly 1,000 capacitors. The current estimate is that there is a worldwide production capacity of 3 trillion MLCC capacitors. By those numbers, nearly 50% of the MLCC capacitors produced are already designated and used strictly in the mobile cellphone sector.

3. Automotive

The hybrid and full electric vehicle industry currently has double-digit growth. However, technical advancements have spilled over into traditional gasoline vehicles with the addition of new technologies in automated driving systems (ADS) including all the new automated gadgets such as parking sensors, auto windscreen wipers, etc.

A standard combustion engine car requires somewhere between 2,000–3,000 capacitors. An electric vehicle has up to 22,000 capacitors required in a single car. Furthermore, the higher temperatures inside the control circuits

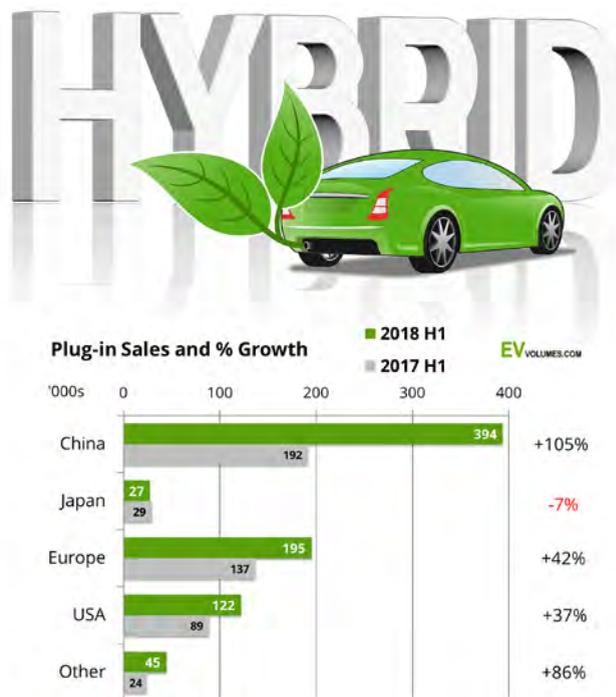


Figure 2: Global hybrid car sales. (Source: ev-volumes.com)

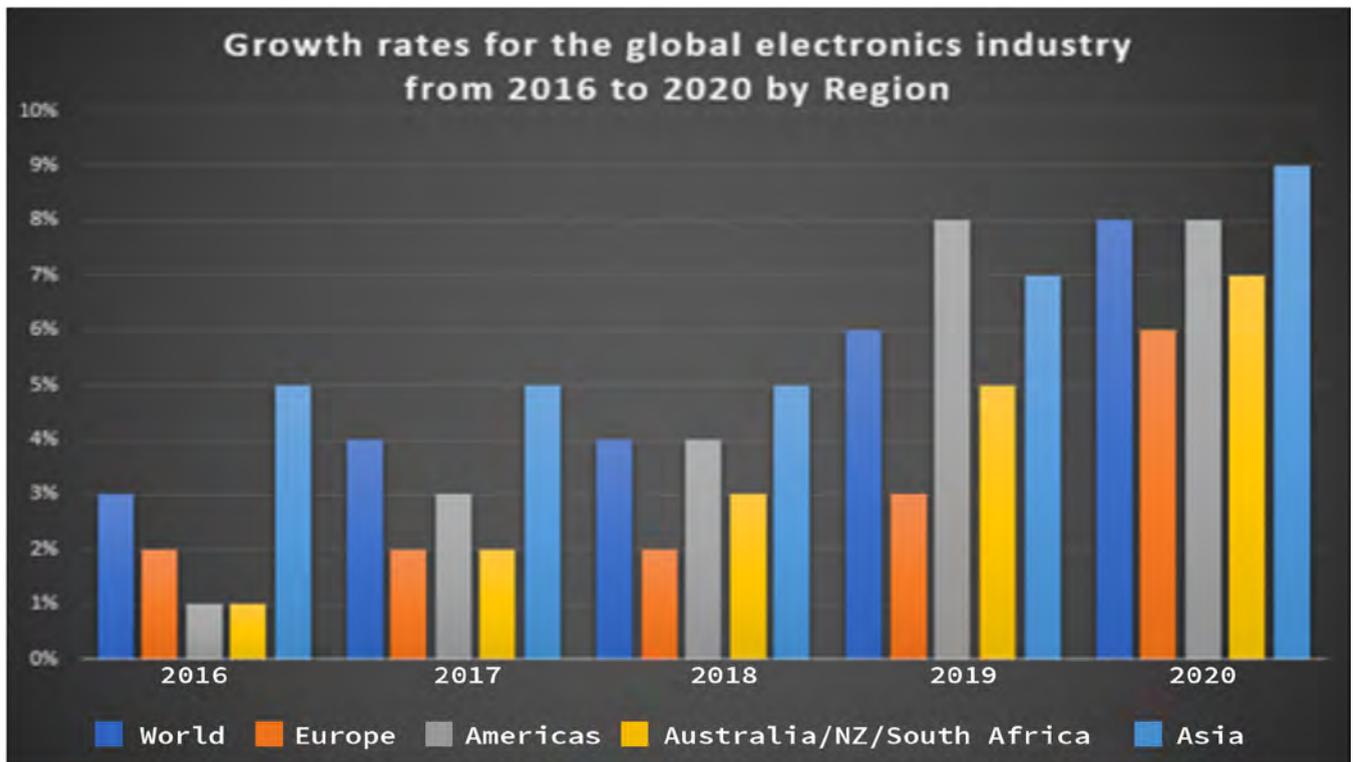


Figure 3: Growth rates for the global electronics industry.

of electric vehicles mean that traditional plastic film capacitors are no longer suitable, so ceramic MLCCs are increasingly being used. This requirement for MLCCs has brought about a new regulatory agency within the Automotive Electronics Council (AEC) whose mission is to promote the standardization of reliability and qualification for automotive electronic components including high-temperature and high-humidity resistance, thermal-shock resistance, and durability.

As a new agency, AEC needed standards and requirements such as:

- AEC-Q100: Integrated circuits (ICs)
- AEC-Q101: Discrete semiconductor components (transistors, diodes, etc.)
- AEC-Q200: Passive components (capacitors, inductors, etc.)

With these new standards, it is estimated that nearly 50% of the components tested have failed, which has resulted in a five-fold increase in the demand for these specific electronic components.

How Long Will This Crisis Last?

The million-dollar question is, “How long do experts think that this will last?” I am not exactly sure, but I do not see this ending anytime soon due to several main reasons:

1. Expected Growth in the Electronic Industry

According to Statista, the electronics industry is estimated to grow 6% in 2019 and 8% in 2020. That is great news for our entire industry, but it comes with some major problems. First, will there be enough coffee to support this massive engineering effort? And second, all of this growth will require new hardware (Figure 4).

2. Part Manufacturers to End Entire Lines of Less-profitable Components

The parts on the chopping block are some of the larger package or case sizes such as anything above 0603 for discrete components. Manufacturers are closing those lines to convert them over to the higher demand components. This narrows the component selection and reduces the supply.

3. Self-inflicted Problems

Many of the part vendors have now switched over to Allocation. In Allocation, manufacturers divide the available inventory, so only a percentage of the stock is given to specific manufacturers. The suppliers, of course, want to work with those companies that place the biggest orders.

On the company side, Allocation has caused an absolute panic. To make sure to have the available components, the new common practice is to double and triple order quantities. Then, the parts consumers stockpile these components for future use. This only puts a further strain on an already fragile system of supply and demand.

Being on the front line with a manufacturing company working to get products off of the drawing board and into a sales catalog, this parts availability issue has had a huge impact on every aspect of our business. From the very first day of a new design, we are forced to question what components we use. However, the problem is that we don't know what the specific conditions are from moment to moment. We have seen the problem from both sides in that components we originally thought would not be a problem have become a problem halfway through a design (and vice versa). It has gotten so bad that on some occasions, once we finally did locate components, the parts would be already gone before we could fill out a purchase order minutes later.

How Do We Get Through This Crisis?

What I recommend to all the PCB designers I work with is to follow a simple rule: This is not business as usual. Do not assume anything in such an environment.

The attitude in a dog-eat-dog world by some is not allow a crisis to go to waste. Many black market and counterfeit components have started to pop up. We have seen parts in our supply chain that were believed to be counterfeit because they did not match the specifications on the datasheet. Thus, the components we can find and get into designs



cannot be trusted. My only response to that is, "Ouch."

This crisis will end. It may take a while for supply to catch up with demand, but it will end. One option—although not a good one—is to bury your head in the sand and hope it all goes away. But this problem will not go away any time soon. The sooner that we realize that as an industry, the better.

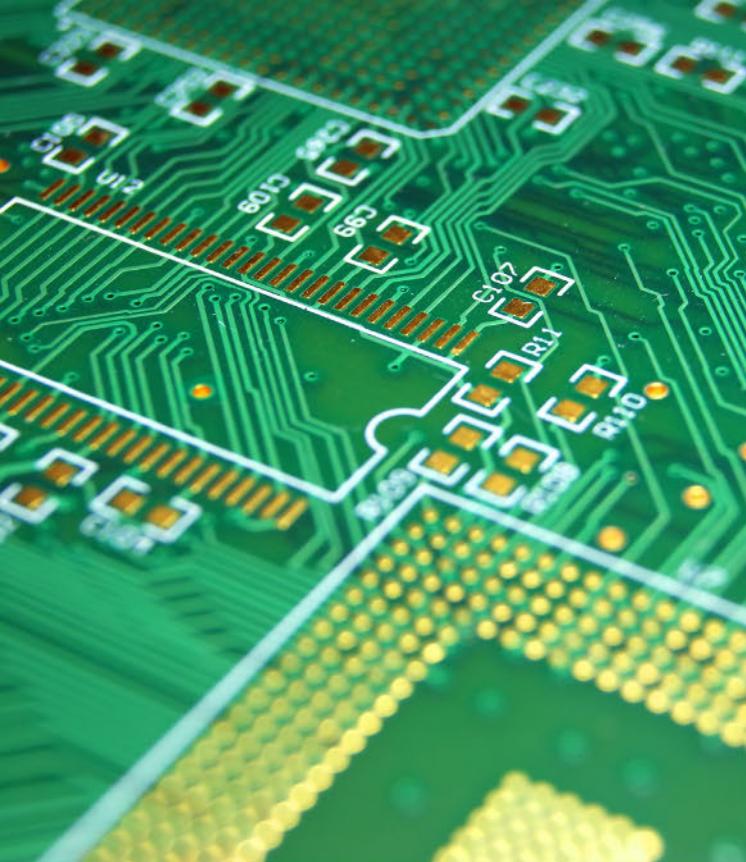
Here are some suggestions to get through this crisis:

1. Design Outside of the Norm

Since we know that there is a narrowing of the supply and a reduced supply for some components, we need to be flexible. Look and see if any of the specific parameters of a component can be adjusted out of what would be considered "the norm." For example, "Do we need to use a 0.1-uF 1% cap for our bypass caps?" If you have any ICs on your design at all, the answer to that question is, "Probably." Since this is the most common bypass cap value, everyone is scrambling for that specific component. You will be able to open more stock of components by changing the parameters especially by taking it up to a 5% tolerance. Many times, the components used are overkill for the class of design. Making that simple change has resulted in a whole new available stock of components.

2. Let the PCB Designer Drive Other Areas of the Process

Now, we are giving over to procurement the list of probable components that may be a



Offshore pricing. Exceptional quality. Local service.

We strive for excellence in everything we say and do.

Our finger is on the pulse of the latest technologies, systems and solutions in an effort to be a total PCB solution provider for our customers.

Why choose Eagle as your total PCB provider:

- Dedicated offshore team with local quality and engineering support
- Seamless transition from prototype to production
- The same exceptional service and support that you've come to expect from Eagle



www.eagle-elec.com

[Click here to learn more about our offshore option](#)

problem early in the design process. This has been facilitated by using tools in Altium 18 such as ActiveBOM. Before, it was the other way around; often, engineering and procurement wouldn't even speak to one another. Now, we are making sure that the information available to us through ActiveBOM is being filtered throughout the company, so the decisions that affect the outcome of a design are known and decided on early in the process not once it is too late. Nobody likes getting those calls from the assembly house telling us that a part has been placed on a design that is no longer available; most likely, a design must be redone because of it. Further, no one likes making that long walk to the manager's office to explain why the deadline was missed because of failing to plan.

3. Use Multi-footprint Components

Benjamin Franklin once said, "By failing to prepare, you are preparing to fail." To that end, we have started to use multi-footprint components, laying multiple footprints on the design for alternative components that we might use if there is a shortage of our first choice. This has

resulted in some interesting layouts to accommodate everything.

In addition, there are the three "Ps" to get through this crisis: plan, prepare, and be proactive. Stay ahead of the problem by not starting with a design that is already in trouble. Many times, engineers will use a previous design thinking that those components are available when many of them may be obsolete or in a deprecated state already. We cannot assume that everything is okay. If you see that parts are already having stock problems or are not recommended for new designs, that situation will not get any better over time—it will probably get worse. Also, realize the further someone gets into a design, the harder it is to make changes without impacting your wallet or time schedule.

A Helpful Tool

ActiveBOM has become one of the most important tools for us. Since knowledge is power, being able to see "live" component stock availability information and appropriate AVLs is crucial. ActiveBOM gives us the ability to rank vendors and set up multiple sources

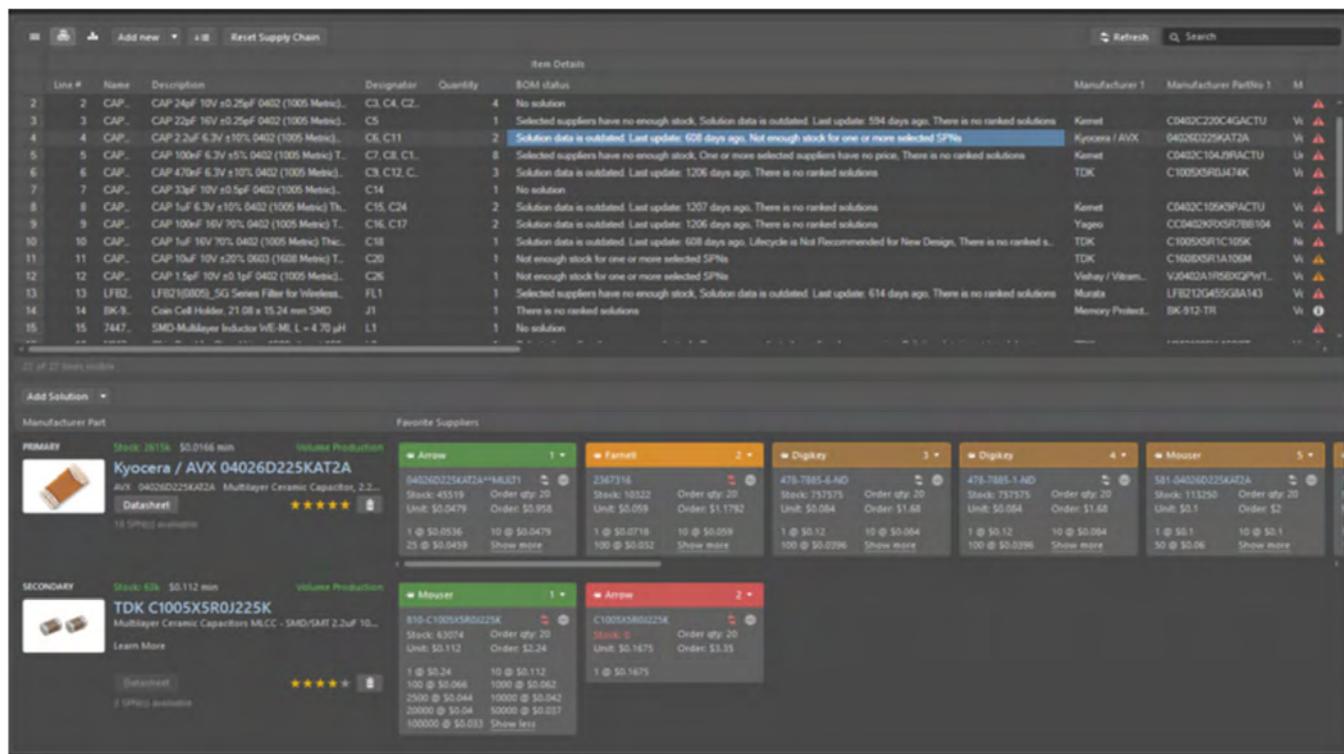


Figure 4: Screenshot of Altium's ActiveBOM tool.

and vendors for each component. We can find this information readily at our fingertips; we do not need to wait until the back end of a design to find out that we just created the company's latest doorstop and stock of bad PCBs. Once we get that schematic done, we can run it into ActiveBOM and find out where our problems are. If there was a second rule after "it is not business as usual," it would be "check component availability often throughout the design process."

Conclusion

In summary, I would recommend that you stay informed. Many of the component vendors publish their component forecasts. Stay aware of trends in our industry. The sooner you know of the problem or the direction, the faster you can make a sound decision on needed changes. This will require reading electronic journals and news. Stay up to date with what is being reported by some of the great PCB industry leaders such as I-Connect007. Sooner or later, the industry will back away from DEFCON 1. **SMT007**



John Watson's career has spanned over 20 years in PCB design. His experience includes various manufacturing companies and PCB design service bureaus with

diverse projects such as high-density digital, DDR, analog, power supply, and high-frequency RF. Now, as a senior PCB engineer at Building Control Systems of Legrand Inc., Watson leads innovative PCB design teams of 50 designers based in several divisions that span the globe where he emphasizes training and mentoring. He has become very proficient in the PCB design process flows and standardization. In addition, Watson is a highly sought out consultant, writer, and conference speaker.

What Is Your Supply Chain Telling You About Components?

Have you purchased any electronics components lately? Have you tried and failed to do so? Allocation is the word of the day and substitutions are your friend. Many, many parts are in short supply or unavailable with extraordinarily long lead times.

Sure, that happens every now and then in this industry. It's a periodic nuisance, but what should you do for the long term? This looks to be a pretty extreme allocation cycle, and I have a feeling that the industry will be different when we come out of it.

At Screaming Circuits, we're getting some interesting stories from component suppliers that might help. What we're hearing is that many passive manufacturers will be trying to move their customers to smaller sizes. They want to consolidate on as few packages as is possible. That means we may be seeing the end of 1206, 0805, and maybe even 0603 form factors for many passive values.

It kind of makes sense. Right now, there might be several dozen different varieties of a 0.1- μ F, 16-V capacitor. Does the industry need that? And if there isn't enough fabrication capacity to make all of the variations, why not consolidate and run more of fewer variations? It won't surprise me if we start seeing fewer voltage ranges as well.

(Source: Duane Benson, Screaming Circuits)



Digi-Key's Dave Doherty: Tweaking the Supply Chain



**Feature Interview by Nolan Johnson
and Andy Shaughnessy**
I-CONNECT007

Digi-Key COO Dave Doherty discusses supply chain disruptions and shortages and shares a number of ways in which Digi-Key is helping to smooth out the delivery of components even with the current turmoil.

Nolan Johnson: What we want to talk about today is the supply chain.

Andy Shaughnessy: This is a big thing for designers. They're wondering, "How do you design



Aerial view of Digi-Key headquarters in Thief River Falls, Minnesota.

something for next Christmas when you can't get the capacitor for 80 weeks?"

David Doherty: That's the question.

Johnson: Right, which is exactly where we're going on this, Dave. From Digi-Key's spot in the supply chain, you have a great view of what's going on. What do you see as some of the major current drivers right now, plus any challenges?

Doherty: It's really two-fold. People ask if our businesses are up a considerable amount this year; we're going to close this year up about 40% after being up 26% last year. So, they say, "What market's up?" the real answer is, "What market isn't up?" If you look across industrial, medical, telecommunications, military, aerospace, and automotive, we're in a very robust part of the cycle where there are more electronics being put into more applications. However, I would say what's putting the strain on the infrastructure as much as anything is automotive.

We visited a number of Japanese discrete suppliers, and they showed us some charts where in the past, automobiles consumed up to 3,000 MLCCs. There are more than 10,000 now, and you know as well as I do, they're going into all aspects of automobiles. There are

Saki's 3D inspection improves process quality, efficiency, and productivity

For Smart Factory, Industry 4.0, and M2M Innovation

SEE SAKI AT IPC APEX EXPO

Saki Booth 1407

Fuji Booth 1317

Hermes/CFX Production Line



AOI & SPI

- Fastest 3D inspection and measurement
- Closed-loop functionality, highest measurement accuracy
- Scalable 7/12/18µm resolution
- Saki Self-Diagnostic Assistant effectively manages maintenance cycles

Bottom-Side AOI

- High-speed, 2D line-scan technology
- Automatic Pin Through Hole fillet inspection to validate quality after selective & wave soldering
- Faster and more cost-effective than 3D bottom-side AOI

AXI

- 100% Head-in-Pillow detection
- World's most accurate inline 3D AXI
- Insulated Gate Bipolar Transistor (IGBT) and Land Grid Array (LGA) inspection & measurement

Award-Winning Saki Self-Programming Software — SSP

No
Programming
Necessary

No
Golden Board
Needed

Programming
Errors
Eliminated

more components in hybrids, and even more in the fully electric cars from the autonomous features, infotainment, and all of the driver assist stuff that we know and love now. The sensors, cameras, monitors, and consumption of electronics are incredible, and even if the automotive market was flat to down (which they aren't), the consumption rates are up marginally, or they've been up. On top of that is increased content per automobile.

So, while that's not a particularly large end segment, we don't ship a ton to tier-one automotive. It puts a strain on our suppliers, which has a ripple through effect to the rest of the channel.

Johnson: Right. When your suppliers are selling into their very large customers, even Digi-Key starts to look like a middle tier.

Doherty: No doubt. And you get into questions such as, "What is the cause and effect, and is this different than in the past?" It certainly feels that that way in both the severity and the longevity of it. I would say that what I find is if supply was instantaneous, you'd never have these disruptions. And even though it's not instantaneous, there's always the ability, as long as there's capital available, to add more foundry and capacity. But there's a little bit more reluctance we're seeing from suppliers to add capacity.

The areas that come to the forefront where there are some of the most commodity of areas, like chip resistors, are the MLCCs that we just mentioned. If you look at those industries and

talk to those suppliers, you know the usage is measured in the number of units, so that's been increasing for the last 20 years or so. But for almost that same time cycle, their overall resales have decreased, so demand for cost reduction in these areas have made it less desirable for the suppliers to continue to invest ahead of the demand and try to keep with it. That's different than what I've seen in the past with memory crunches or other areas of semiconductors.

Johnson: We're hearing a lot of feedback about product teams running into issues where, surprisingly, even standard commodity parts are being obsoleted way sooner than one would've thought.

Doherty: Yes, I would say I back that. From my perspective, I think we've seen that as well. I could validate that observation is accurate, and for a lot of these suppliers, it's coming down to economics. If you have a certain amount of capacity and you're not going to expand it, where do you make your margins? That's going to dictate where you're going to put your wafer starts these days. And some of it is the most standard of commodities that have been impacted the most. The prices have been driven down into the mud, and they're asked to produce more and more product each year at less and less total resale. It's a model that's not sustainable.

Johnson: Some of the feedback we've heard, as we've been researching this topic, included strategies to start going to the smallest, newest parts that they can use.

Doherty: Clearly, suppliers have been putting their focus on smaller case sizes where they can get more units per wafer and then get a little bit more economies of scale. The other is looking at options, especially if you talk about resistors and capacitors; there are a number of different flavors. I know most of the readers are savvy enough to know you can buy something with a higher tolerance that's going to be a better-than part.

Put all of those options on your AVL because



when you turn those Bills of Materials over to your purchasing folks, more often than not, they're trying to buy to a part number. More and more today, there are different part numbers. Some are just packaging, some might be a 5000-piece reel versus a 10,000-piece reel. Again, others are better-than or equivalent parts. The more the engineer can specify a broader selection of products on the front end, the better chance the purchasing agent is going to match up to something that's going to fit that need. That's just taking the exact need that you have. The more you can work in some flexibility into your design, the better off you're going to be as well if you can accept a little bit wider range on tolerances in some of these parameters.



Johnson: I know that a lot of designers work with their design on one monitor and the Digi-Key website up on another as they search for the parts that have the right parameters for their circuit. How do you see Digi-Key improving that decision-making process?

Doherty: It's a great question. Part of it I want to make sure that we share too, is we've been fortunate. We think that our suppliers have been as generous as they can be with us because our primary model is to support NPI. Our suppliers appreciate that while they have to support today's demand, they can't cut off tomorrow's next-generation products because that's their future livelihood.

Johnson: You're right.

Doherty: Our primary model is to support that NPI and design activity. Now, suppliers' MOQs (minimum order quantities) are usually high enough that when we buy the necessary product, we need to support that. There is some additional inventory that supports spot shortages or unanticipated demand from some of our customers, but that's opportunistic. That's not strategic for us, and so our commitment

and desire is working with suppliers to have sufficient quantities on the shelf to support those opportunities early in the design stage so that they can prototype and get to preproduction. They can validate the design, and we keep the innovation flowing while their counterparts in purchasing focus on keeping their existing supply chain for their production needs to stay up and running.

We're bringing in more inventory. I would challenge anybody to do so, whether they've been able to bring in the amount of inventory in the last two years at the same rate we've brought in. It's astronomical amounts. Being private, we have the ability to do so; we're not measured on terms or financial performance. We don't have Wall Street looking over our shoulders, so we saw some signs of this uptick a little over two years ago and started to aggressively purchase more product. You have physically just as much product as possible available on the shelf. Then ask, "Can we do a better job with our parametrics so that we can compare functions and our users can look and see their BOM, critical parameters, and widen their search to see what parts meet that capability or add more parts to the AVL on the front end?"

We value and hope designers continue to trust and have our website up in conjunction as they work on their design. We want those tools, parametrics, and additional content to be there as well so that they can get the flexibility we just alluded to, which makes it easier

for the purchasing folks.

Johnson: I think you've also answered our next question as well, as to whether this is affecting your major customers versus the smaller volume customers. Do you see Digi-Key taking any uniquely different steps for the smaller, more innovative design teams?

Doherty: When I encountered that question, I chuckled to myself a little bit because we really don't distinguish between large and small customers. We tend to play in small- and medium-size quantities with all customers, so every customer is equally important. You can be the largest automotive or handheld devices



company, and they typically use us for innovations or short-run productions just like the company where their entire production line is similar or maybe even less volume.

Everything about our model, whether it's tech support or the pipeline of inventory, services that space regardless of customer size. One of the first things we did was cut back on some of the high-volume column breaks. We would prefer to have a large number of customers come to us to buy smaller numbers of quantity each versus some large OEM look for us because our model will not make up for the shortage constraints across the industry, or frankly, even across any single OEM or large CM. We want to continue to support that long

tail of customers, typically more on the front end of their design or their unforeseen spot shortage that fits our model.

We look at our in-stock rate and do everything we can to continue to keep that up. Again, the suppliers have been very supportive because they see two things. One, they want to support that design activity for their next-generation products. Two, they find it's an easy place if they have any additional upside. Let's say they were planning to produce 100,000 units and they get 102,000. For any of that upside capacity, they can put into one place and very easily channel it to Digi-Key. Then, we can expose it globally for them and try to reach that wide net of customers so it doesn't just get consumed by that one large OEM that's screaming for more product.

We think we've been in a little better situation than most, and inside of that, we do some of the things we alluded to around content and parametrics to work with designers. There's no doubt this isn't a fun time for some of these individuals in trying to source and find products. However, we want to be that trusted partner still, and the one thing we do see is regardless of the constraints, our customers still want to go to authorized sources.

Authenticity matters. They don't want to risk having a counterfeit product, and we'd like to think that's the other reason they come to Digi-Key first is they know and trust any and all of the product we have. That model will never change. It's all coming directly and only from manufacturers that we authorized.

Johnson: What's the perspective at Digi-Key? What are the long-term parts of this shortage that we're going to be dealing with, and what are the blips?

Doherty: For anything that's been more than six or seven quarters, I would say there's light at the end of the tunnel. I think the worst is behind us, although some would say there are



Ready To Take The Next Leap

APCT Investing In Technology To Support Our Customers



Printed Circuit Board Solutions

APCT is leaping into the new year with confidence after investing \$4.5M for your success!

- Increased Engineering Personnel For Support
- New Equipment Sets For Additional Throughput
- Improved Systems For Assured Reliability

APCT: Investing For You

APCT Offers

TECHNOLOGY Standard: 2 - 28 Layers
Advanced: 30 - 38 Layers
Development: 40+ Layers
Lam Cycles: 7x
Micro BGA Pitch: .2 Millimeters
Flex/Rigid Flex: 2 - 30 Layers

CERTIFICATIONS ISO 9001 Certified
AS9100D Certified
NADCAP Certified
MIL-P-55110 Certified
MIL-PRF-31032 Certified
IPC 6012 Class 3 & 3A
ITAR Registered

CYCLE TIMES Through Hole Technology

- 2 - 10 Layers, 24 Hours
- 2 - 24 Layers, 48 Hours

HDI Technology

- Via in Pad: 48 - 72 Hours
- HDI: 3 - 15 Days*

*Depending upon # of Lam Cycles

QUANTITIES

From Prototypes to full scale Production orders with off-shore solutions through APCT Global



still going to be constraints. I'm going to be a little bit of a contrarian here because I find in our industry, when things are good, people never think there will be another constraint, and when there are constraints, they think we'll never come out of it.

Right now, it would be irresponsible for me not to share with folks that lead times continue to be long in a number of product areas like passives, so stay close to us or any of your sources of supply. But I also tend to find that suppliers are adding capacity and tend to normalize fairly quickly.

Perhaps a large OEM has double-ordered in their supply chain, and once they start to normalize, they trim back their backlog. The next thing you know, that trimmed-back backlog frees up some capacity for somebody else who may have over-forecasted. The correction tends to come more quickly, so I think we'll still be in some level of constraints Q1 and Q2. However, I think the uptick of the supplier activity, as well as the fact that we're seeing some slowing on the general production demand, could help. If you know what to attribute it to, whether it's some of the tariffs or just general economic conditions seem to be a little less robust, I think the combination of the two will lead us to more

normal conditions by the second half of 2019. **Shaughnessy:** I've heard a couple of fairly intelligent people say that this is actually a sign that things are going well. Maybe not the 80-week lead time in itself, but it's a good problem to have because when we come out of this, we'll be stronger than we were. What do you think about that?

Doherty: I think it's a good thing that it doesn't feel good right away, but our suppliers are taking a more measured approach to capacity. I mentioned earlier they've been reluctant and careful not to add too much capacity too quickly. When the systems are in balance, that's optimal. For our suppliers—us as consumers or customers—I'm sure we'd love to get things for free, but we realize it's not a sustainable model. So, if our suppliers can match the capacity with the true demand where they can have an economically sustainable model, that's good for the industry.

Again, some of the problems are that we've gotten ourselves into is a situation where we had overcapacity for an extended period of time, and responded to our own boards and shareholders as they had to. We cut back or froze capacity, and demand kept inching up to the point that it flipped on us. Having some level of lead times isn't the worst thing in the world.

Predictable lead times aren't an issue for us. We plug them into our system, give the information to our suppliers, and buy ahead. It's the quickly changing lead times where your system is gearing towards nine or 18 weeks, and within four weeks, it flips out to 60 and you can't react. That's the unpredictability that causes strife in our supply chain. I think this is going to pull itself back a little more slowly. It's taking longer but in a more organized fashion. To your point, Andy, I think it's going to be a healthy return.

We talk about soft landings in the economy. The worst thing that could happen is they all overproduce capacity and flip this back into the situation where none of them are making money or can sustain their model, and then we're back into maintaining this unstable environment of production and availability. Does

that make sense?

Shaughnessy: Sure. There are so many different takes on this. I just wanted to hear your side of it.

Doherty: I would guess there isn't anybody who could say it's a great thing for suppliers to have extended lead times. They are all working their tails off. They realize that when lead times have been pushed out, that means there's going to have dissatisfied customers and will work hard to ensure that they can they expand capacity and yields.

This is where I think the users can help themselves. The other area that we didn't talk about is looking at different technologies. There are a lot of applications for polymers or tantalum in the capacitor world where, again, the more flexible you can make your design and the more options you can accommodate, the better position you're putting your company to be able to source product.

Johnson: That explanation makes a lot of sense to me. Everything starts to tie together—part availability, pricing volatility, rapidly changing lead times, and premature parts obsolescence all come together as being symptoms of a measured response to a dramatic change in demand.

Doherty: I think that's more than fair, Nolan. I think the solution is communication. The partners that you work with—specifically for those who work with Digi-Key—reach out and ask, “How can we help you with information? Can we show you the number of customers?” We have more and more API relationships with customers where we can provide information and help them. We have 100+ engineers on staff. We can review their BOM and give them a risk assessment, such as, “This product has much fewer customers than these other variations.”

We, and frankly our suppliers, want customers to design good, safe, long-life products. No one likes to see a customer in dire straits where there's been an obsolescence, and typically, those decisions aren't made at the spur of the

moment. There's some thought that goes into it, so use your partners early in your supply chain, and save yourself that grief where the first time you pick up the phone isn't when you have a part shortage.

Johnson: Dave, who do you want to talk to in the design chain? Do you want to talk to the original specifying engineers or the buyers? Where should they be plugging in for that conversation with Digi-Key?

Doherty: From a title perspective, that varies company to company, but the definition is the person that has an influence on that BOM. It's really that AVL. For some companies, it's one and the same; the buyer is the engineer. But in many of the larger companies, the buyers will say, “My hands are tied. Once the BOM is handed over to me, I'm constrained. We've already gone through our testing and validation.” Then, we need to be further upstream if we're going to provide any significant value.

Johnson: That's a thought-provoking answer. How does Digi-Key plan to increase that connection and make that known to the designer, so they know to check in with you?

Doherty: We get about 1,400 contacts—technical support questions or inquiries—from our customers a day. A lot of them already know to use us. I think so many people have come to





Digi-Key's planned expansion in Thief River Falls, Minnesota.

expect such low service levels that they don't realize there are still some partners out there who believe that it's their responsibility to invest in this whole design chain.

Our engineering staff is available to help consult. We have customers physically send us their BOM and ask us to score it. There are third-party software tools out there that will do that. We do it with some of the information, and we have visibility for free. When they're in the purchasing mode down the road, we want that to be an easy, hassle-free experience, and as we've stated a couple of times now, you can't impact it at the time of procurement. It has to be upstream of that, so start with a phone call, webchat, or an email to us, and if not Digi-Key, there are other services out there to subscribe to that I would say are worth their weight in gold in times like this if you can design that little extra flexibility.

I continue to be amazed at the proliferation of part numbers, the uniqueness, and again, in some cases, it's ironic where it's just the case of a small versus a large reel. One of the purchasing people will say, "No, I have to buy this particular part. Don't you have any?" We say, "No, but you can get two small reels to meet your needs. It will fit your same pick-and-place equipment, but it's going to have a different suffix so the manufacturer can designate the

small versus large reel." They'll say, "Well, it doesn't match my BOM." In some cases, it's as simple as that.

Johnson: Dave, is there anything else you want to mention?

Doherty: This is an important topic for readers. Our whole livelihood is helping those folks find hard-to-get parts, and we have resources on staff to provide that support. So many times, you get stuck, call a company for help, and hear, "Dial three for this, dial six for this, etc." Next thing you know, you're back at the beginning. When you call Digi-Key or use our webchat function, you're going to get somebody ready to help.

Finally, we're just in the process of closing in our expansion, which will almost quadruple the size footprint of the building that we're in and this warehouse is across the street. It's just a further commitment to show that we're excited about where this industry's going, and we need more space to inventory more product.

Johnson: Thank you for your time.

Shaughnessy: Thanks, Dave.

Doherty: I appreciate it. SMT007



SMTA
Pan Pacific

Microelectronics Symposium

Addressing the Latest Research On:

- *Advanced Packaging & Processes*
- *Automotive Systems & Hardware*
 - *Cleaning Technologies*
 - *Heterogeneous Integration*
 - *Inspection & Test Techniques*
- *Interposer & Packaging Technology*
 - *Materials & Reliability*
 - *Nanotechnology Applications*
 - *Trends, Roadmaps, and more...*

February 11-14, 2019

**Kauai Marriott Resort & Beach Club
Kauai, Hawaii**

Register Today!

www.smta.org/panpac

A hand in a dark suit sleeve is pointing its index finger at a blue rectangular button with the word "Search" in white. To the left of the button is a white rectangular input field containing the text "Part number or keyword". The background is a light gray gradient.

Part number or keyword

Search

Dan Schoenfelder: Searching for Parts in Real Time

Feature Interview by the I-Connect007 Editorial Team

The I-Connect007 editors recently sat down with Dan Schoenfelder, vice president of business development at Octopart. We discussed online parts libraries and the impact they can have on choosing parts based on availability data during the design process.

Nolan Johnson: Dan, could you give us an overview of what you and your teams do at Octopart?

Dan Schoenfelder: I run the business and operations teams at Octopart. We're a small team of about 20 headquartered in Manhattan—the Flatiron District—and that's pretty much where all of our staffers are. We are a search engine for electronic components, and our biggest goal when it comes to what we're trying to accomplish is to democratize information for those in our industry who need it whether it's designers, engineers, buyers, etc. Octopart itself is a very widely used platform. We have more than 900,000 unique visitors per month who visit

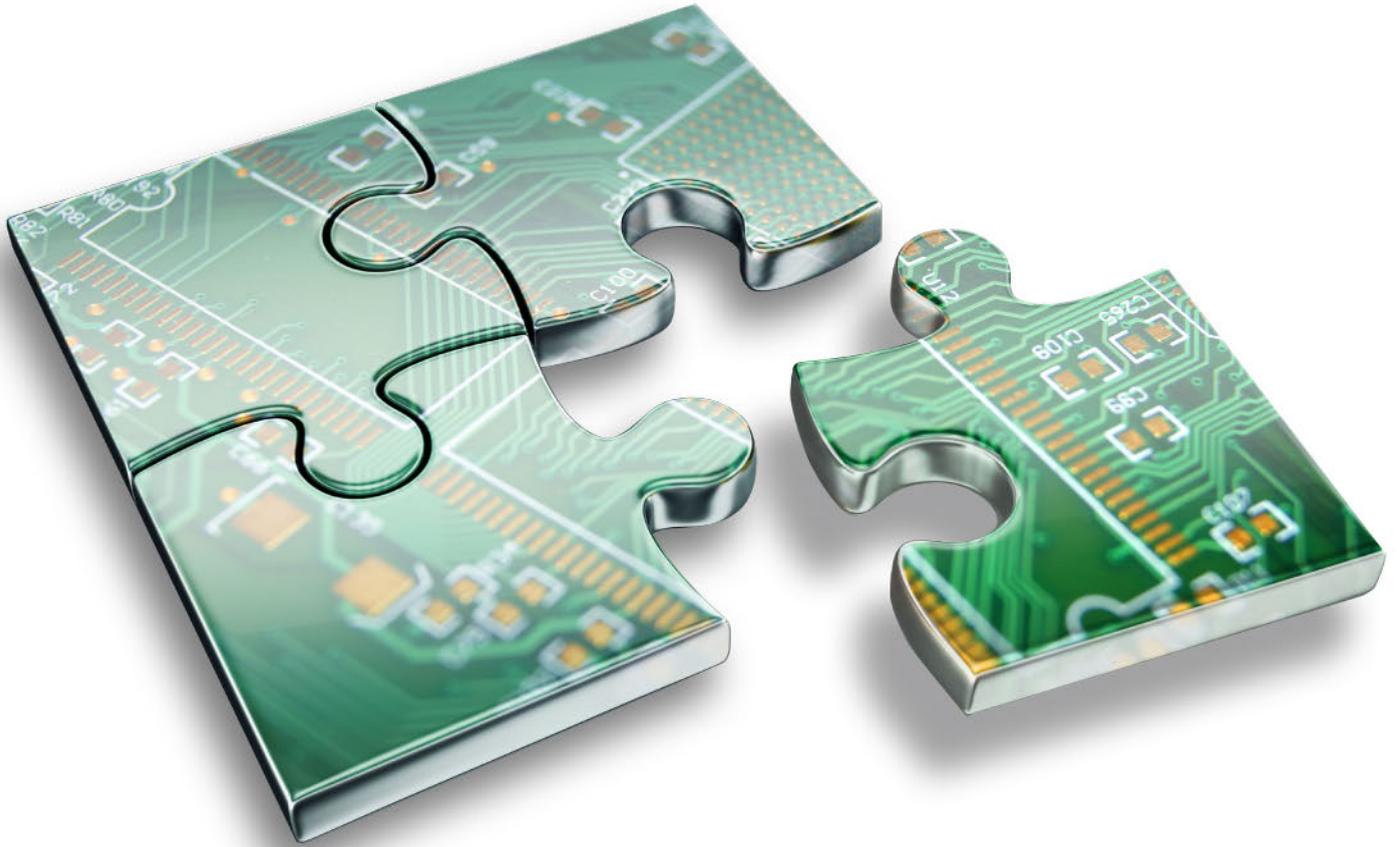
our site and search for products. We receive more than 2 million searches per month for electronic components. We find that our audience is geared toward being more technically focused resources, so we see ourselves on the front end of that design experience for a lot of electronic assemblies.

We are owned by a company called Altium, whose primary product is ECAD tools for circuit board design, and their flagship product is Altium Designer. We've been a part of the Altium family for about three years now.

Johnson: That's a great overview. Dan, one of the things about Octopart is you built a pretty unique spot in the supply chain. It's emerging and disruptive. You have a different perspective doing what you do, standing between designers as they design and make decisions about their components in the CAD tool environment, and then having that conversation with manufacturers and distributors. Can you talk about that experience?

Schoenfelder: First, just touching on that something you mentioned, we're in an emerging

Contract Manufacturers: Need the perfect fit? ASC is the missing piece.



Finding a reliable PCB supplier can be difficult for contract manufacturers with a wide variety of project needs. ASC has the technology, experience and engineering support needed to deliver on-time solutions for everything from quick-turn prototypes to the most demanding, complex applications.

[More about our capabilities](#)



American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

www.asc-i.com | (630) 639-5444

space in this industry. To give you an example, some of the most recent numbers that I've seen indicate the semiconductor industry was up 17% year after year when comparing July of 2017 to 2018. Octopart is outpacing industry growth by more than two times. From what we're seeing, our site traffic and activity and the number of searches is increasing by more than 40% each year. In some ways, our business is benefiting from what is a good time in the electronic component industry when it comes to sales. At the same time, I think we're



Dan Schoenfelder

outpacing that significantly as well. It speaks to the desire of buyers and engineering professionals to have more readily accessible information.

We do find ourselves in an interesting position, and one of the value propositions of Octopart is that there's no barrier to entry for our user community, meaning that you

don't have to provide any identifying information to get access to data. The data that we have on our site includes technical specifications for devices, data sheets, downloadable CAD models, and simple things for comparison like price and availability. We have over 250 distributors and manufacturers that participate and list inventory through Octopart. We put a compelling amount of information out there that can be used at various stages in the product lifecycle of a design.

Andy Shaughnessy: Dan, when you talk to designers, what are some of the biggest challenges that they come to you with? What are their bottlenecks as far as components?

Schoenfelder: There are several areas where Octopart provides value there. I think that designers want to know a handful of things. Typically, if you were to survey our user community when they're looking for devices

and something to put in the design, we tend to have two elements of searches here. There's a search that occurs when somebody knows the particular device that they're looking for. In those cases, what folks are looking for is, "Can I get it? How soon can I get it? And how much does it cost?" When that part is already defined inside their organization, it's on their ABL or is an approved device in a design.

Then, there's the part search and discovery piece, which is people who come to Octopart looking for something where they may not know the part number or manufacturer, or they may just know the function of the device. They're doing more product research. We have two different classifications of search. And again, for those who know what they're looking for, they're coming to us to see, "Can I get it? Is it widely available, and therefore, safe and low risk for use in my design? How quickly can I get it?" And what does pricing look like for those devices?" What we find is that's the more straightforward side of the search for us.

The more challenging thing is we're trying to expand our capabilities to support folks searching for devices that don't know exactly what they're looking for. They might not have a part number, don't know the manufacturer, or may just have the function of the device. In those types of engagements and users, they may be looking for things like data sheets or specifications on the site. Or they may be looking to download CAD models because they don't have them available on their existing libraries as well. We have a wide variety of use cases, and it's hard to pin down our user community into having just a single-use case for Octopart.

Patty Goldman: We keep hearing about the shortages of components and the long lead times. How does that figure into the number of searches that you've been seeing lately?

Schoenfelder: I think there's no question that constraints across various components contribute to the number of searches that we see on Octopart. And certain product categories have a density of search that's far greater than others. Certainly, there are passive devices right now

that are in high demand and have scarcity, and we see that. I don't want to overstate the relevance of the information and data that we have at Octopart, but I do believe that we have our finger on the pulse of activity in the industry. With our data, we're trying to use that to help our search experience, and people find what they're looking for more readily based on the volume of searches we're seeing and the types of commodities that are being searched. So, we are seeing an uptick in activity overall, and spikes inside of specific commodities that are constrained.

Stephen Las Marias: We're seeing that designers have to make obsolete some of the components that they are designing into the circuits and products that they're doing because of obsolescence issues when it comes to applications. The product would have to work for longer, for 10–15 years. From your perspective, how does this impact the industry?

Schoenfelder: I would say that if there is a specific area where there's deficient information in our industry, it's around obsolescence of products. There's not any one reliable place to get information across several product and commodity categories. And the information that is out there is often not accurate if you talk to specific manufacturers about their plans for the end of life in products and/or discontinuance. It's hard to find any resource out there that is extremely good at either identifying or predicting obsolescence. There's no question that contributes to activity on Octopart. That is a piece of this scarcity that we just referenced, but obsolescence is a piece of that too.

There's no question that one of the big value props of Octopart is the aggregation of information. When times of scarcity come, we are a place where consumers of products can determine if there's availability in the marketplace across hundreds of distributors around the globe. That is certainly one of the good use cases for Octopart. When there are times where a device is constrained, users will flock to Octopart to see what inventory exists and how they can secure that inventory for their products.

Johnson: From a supply chain perspective, it seems to me that a company like Octopart would be useful to the manufacturers and distributors to communicate that sort of availability information. How are you developing that conversation?

Schoenfelder: That's a great question, Nolan. Thank you for asking that. For us, we've pretty much talked about our user experience on-site today, which is extremely powerful but typically limited to one query at a time. There are a couple of ways that we're addressing more enterprise-grade solutions through Octopart. One is we have a BOM tool on our site where users can upload an entire bill of materials to get information back—pricing and availability being the primary value there.

We have a BOM tool on our site where users can upload an entire bill of materials to get information back—pricing and availability being the primary value there.

We also have the Octopart API, and our API is extremely powerful in that it has excellent documentation. We also provide the pricing and availability I just referred to in our BOM tool. In addition to that, we have technical specifications, data sheets, and other technical elements available through our API. We have enterprise-grade customers that come to us to supplement the supply chain information that they require in their ERP and MRP systems, and then also to help them again on the MRP side more with resource planning for materials. Our API, while we're working on enhancements for it right now, still has a significant amount of usage and use cases for enterprise-grade customers.

Las Marias: When it comes to the shortage and obsolescence of electronic components, another supply chain issue that can arise is counterfeit components. How do you address that?

Schoenfelder: That's a great question. At Octopart, we identify authorized sources of inventory. All authorized sources of inventory have to complete a document for review before being listed as authorized. We try to ensure that users are first directed towards any source of inventory that is contractually tied to being able to sell a particular part. For us, that is our primary mechanism for making sure that users are directed just to inventory that has traceability and pedigree.

Las Marias: From your perspective, what other issues do you see right now in the electronic components supply chain?

Schoenfelder: For us, the biggest gap that we see right now for supply chain is every entity is looking for automation today, but that automation is happening very much in the way of mass customization. Every entity is looking to do their unique integration of data and resource cloning. That stratification is a huge challenge for an entity like Octopart. There are countless numbers of tools available out there, and they all have moderate usage. I don't think there is a dominant system or source of information for those systems, and that stratification creates complexity that makes it challenging for Octopart to be able to integrate with all of them. We find it both on our site and API side that you're constantly amazed by the number of use cases there are for data.

Johnson: Dan, I would have to think that at some point, the semiconductor manufacturers themselves—the source for all of these components—would want to buy into getting their parts definitions, footprints, and all of the information for their parts put collectively into databases like yours. It seems to me that there's a marketing opportunity for them to prerelease parts that are underway for the engi-

neers to start to look at them before they're actually available and search and design them in, increasing their adoption rate—those sorts of marketing approaches using Octopart as a communication channel. Do you see that emerging?

Schoenfelder: I do, most definitely. I think that most manufacturers have used their direct and distribution channels to market their products exclusively in the past. Emerging businesses like Octopart provide them with a new medium and path with which to identify demand and potential new users of their products. We definitely see a tighter connection being built between Octopart and component manufacturers. That is both to drive awareness of new products, but also to make content accessible to new users as well. And again, that content could be as simple as new data sheets and part specifications and parametric information, or it could be stuff that's even more valuable such as CAD content. And when I say CAD content, I'm referring to footprint symbols and 3D renderings primarily.

It's interesting, as we survey our user community, we find that CAD models are something needed very frequently in the design of products, but are a huge headache when it comes to creating them themselves—an engineer has to create those models themselves. We see a huge need being satisfied by getting CAD models.

Nolan, to get back to the question you had about how manufacturers are utilizing Octopart, I think making it as simple as possible for someone to design their products in is what they're attempting to accomplish. Octopart is becoming more of a medium for manufacturers to accomplish that.

Johnson: Do you find that major distributors like Digi-Key, Mouser, and Element14 are cooperative, or do they find it threatening to have Octopart stepping into this conversation in a place where they used to have it all to themselves?

Schoenfelder: We have an incredibly collaborative relationship with all major distribu-



Wired Differently, Connected Together



eptac

TRAIN. WORK SMARTER. SUCCEED.

EPTAC makes it easy. Complete the course, pass the exam, receive your certification. Best of all, add credentials to your technical expertise with an industry recognized certification.

Call 1-800-64-EPTAC, email sales@eptac.com or visit eptac.com to find a class near you!

tors. We work very closely with all of them to ensure that there is accuracy and integrity to the information of theirs that we publish online. I would say that we have an excellent relationship across the board with most major distributors, and a lot of regional and smaller distributors too.

Shaughnessy: Where do you go from here, Dan? What do you see the company doing in the near future?

Schoenfelder: We're constantly striving to improve our search experience, and that includes both the technical methods in which our search takes place behind the scenes and the visible user experience on our site. This is a day-to-day effort for us. It's something that we take very seriously, and we're constantly planning and preparing for ways to improve the user experience. We feel like we have the best search in the industry, but we're not going to rest at that. We're going to keep striving to improve.

We feel like we have the best search in the industry, but we're not going to rest at that. We're going to keep striving to improve.

Our goal is to be the dominant source for search in the industry. That's where we want to be and how we'd like to be viewed. Certainly, improving our search capabilities is a huge priority, as well as adding to the data that we have available to our user community and constantly striving to get more information is something that's critical to our success.

Finally, we are working on what I referred to before as the API and our data syndication capabilities so that we have methods for disseminating information, not just through Octopart.com, but through ways that can be utilized by enterprise-grade tools.

Las Marias: Do you see the electronic component shortages easing up soon, or do you think this will persist in the next foreseeable future—two or three years perhaps?

Schoenfelder: From the data that we have available and the usage we have on our site, all indications are that the current trends are going to continue. It's hard for me to say, from where I sit, what's going to happen even three, four, or five months out, but I believe that Octopart is uniquely positioned in a place that when this trend starts to subside, we will be one of the first to know.

Las Marias: What advice can you give our readers when it comes to dealing with their supply chain management issues, especially during this component shortage environment?

Schoenfelder: That's a good question. Do as much as proactive work as possible to understand the landscape of your supply base and the componentry that is part of your designs so that you understand what limitations you may have and how to address those.

In my experience, before I was part of Octopart, I worked in the digital group at Arrow Electronics and was in distribution there for the better part of six years. Before that, I was at Flextronics in the contract manufacturing world. I've had the good fortune to see this industry from several perspectives, and there's been a trend that I've seen over the last almost 20 years in this industry that there is less and less ownership of the manufacturing and supply chain process by those who are doing the design work. While we focused a lot of in this discussion around design discovery of information, I think we're hitting on one of the other use cases for Octopart, which is, "How do I maintain and manage my BOM and avert risk once that design is stable?"

This prevailing trend that I'm talking about is that those that do the designs are less and less involved in the manufacturing without sourcing of the entire manufacturing and supply chain process. Again, I would recom-

mend those that design products understand their BOM, risks, where they may be able to add a second source, and how they may be able to shorten lead times. Octopart is one of those sources of data that can help in decision-making for a lot of those cases.

Goldman: That's really good.

Las Marias: Yes, because in our previous conversations in the industry, they're saying that the designers should just go ahead and design, and then they leave it all up to the fabricators and assemblers to figure out how they're going to manufacture those designs. You're saying that there should be communication between them.

Schoenfelder: Absolutely. I think there needs to be communication in the design cycle. Any design is a living, breathing thing as long as it's still being manufactured, and there's a dynamic element to how to manage the supply chain as long as the design is alive. I think that those who are doing the design and development work need to work with supply chain professionals in their organizations both early and late in the lifecycle of any product.

Barry Matties: That's a common statement that we hear time and time again, and it's maybe what we call intuitive wisdom, yet so many people do not heed that advice. Why is that?

Schoenfelder: I'm a big believer in the power of data and using data to guide decision-making. I view Octopart as being one of those sources of data that helps make better decisions at any stage in the product life cycle. When you talk about this problem, Barry, I think data is a pretty good way to address it, and it's hard to argue with good information. When armed with the right information, decision-making becomes all that more impactful.

Matties: Part of the problem with data in today's world is there is so much. You have to have the wisdom to know what the important data is and ignore the rest.

Schoenfelder: Yes. Cutting down on the noise of information is extremely important. Most companies right now are trying to do creative things with data and information, and a lot are just creating a data lake or someplace where data resides but is not properly utilized. I think that appropriate utilization of information is really the key, not necessarily just the information itself.

Matties: If you were to give advice to what you feel the most critical of data would be for a designer to look at, how would you categorize that?

Schoenfelder: This is a tough one for me. I'm not a designer, but I think for anybody who's going into a new design, having a variety of information sources available to you about the componentry that you're planning to use is important. Understand the following questions: Are these products available on the market? How are they priced, and is that consistent with the constraints that I'm going to have in my design? Is there any information out there that leads me to see risk, meaning is this product distributed widely? Does it have several distributors? Are those distributors stocking the product? What is the current lead time for that product when it's not stocked? Again, how is it priced? Are there data sheets? Is there parametric information? Are there CAD models that exist for these devices?

All of this information when widely available, and I think it drives confidence that what you're designing has some stability to it. When that data and information is lacking, it should be a red flag as to the viability of a product and any complexity it might add to your business process because it's just not widely available.

Matties: Thank you for your time today, sir.

Schoenfelder: Thanks for the interview. I appreciate it. SMT007

ein Electronics Industry News and Market Highlights



Test and Measurement Equipment Market Worth \$32.3 Billion by 2024 ▶

The overall test and measurement equipment market is expected to grow from \$25.7 billion in 2018 to \$32.3 billion by 2024, at a CAGR of 3.90% during the forecast period.

Artificial Intelligence Meets Materials Science ▶

A Texas A&M University College of Engineering research team is harnessing the power of machine learning, data science and the domain knowledge of experts to autonomously discover new materials.

Panasonic Utilizes 100% Renewable Energy to Power the Consumer Electronics Recycling Plant ▶

Not only has Panasonic Group's consumer electronics recycling plant, Panasonic Eco Technology Center Co., Ltd. (PETEC) made efforts over the years to reduce the energy consumed, it has also implemented solutions to create energy and to procure electricity created by renewable energy.

European Spending on Digital Transformation to Reach \$256 Billion in 2018 ▶

DX spending is expected to steadily expand throughout the 2017–2022 forecast period, achieving a five-year compound annual growth rate (CAGR) of 15.1%.

USMCA Will Strengthen Global Semiconductor Supply Chain ▶

The USMCA, if successfully ratified, will be the first U.S. trade agreement to incorporate many new and higher standard trade disciplines that will strengthen the digital economy and the global semiconductor supply chain.

India Smart Wearables Market Finishes Strong with 102,000 Shipment Units in 2018 Q3 ▶

The overall India wearables market saw a 17% year-over-year (YoY) growth in the third quarter of the year as vendors shipped a total of 897,000 units in the country.

Stronger Public Private Partnership Required to Drive Industry 4.0 in Malaysia ▶

The recent budget focused on the Industry 4.0 blueprint, titled "Industry4WRD," which aims to make Malaysia the prime destination for high-tech industries in the region.

Worldwide Semiconductor Equipment Billings Drop to \$15.8 Billion in 3Q18 ▶

SEMI reported that third quarter 2018 worldwide semiconductor manufacturing equipment billings dropped 5% from the previous quarter to \$15.8 billion but are 11% higher than the same quarter a year ago.

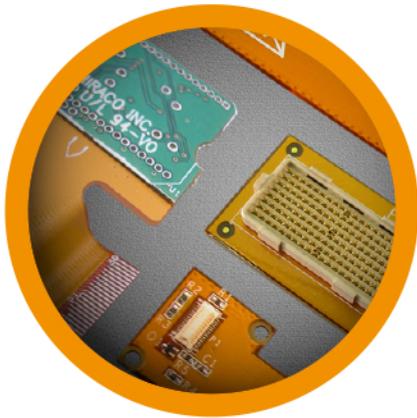
Southeast Asia Electronics Supply Chain Set Sights Towards Smart Manufacturing ▶

Southeast Asia is a region that is fast developing. It has evolved from an agricultural society to one of the fastest growing regions in the world within the span of a century.

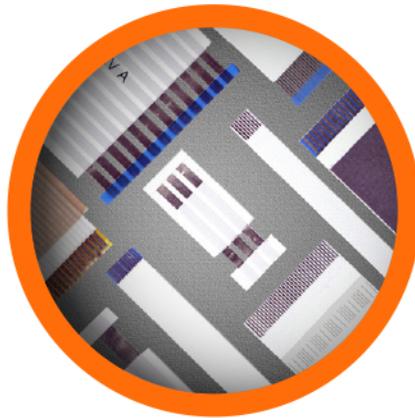
Semiconductor Equipment Sales to Reach Record Growth of 9.7% to \$62B in 2018 ▶

Worldwide sales of new semiconductor manufacturing equipment are projected to increase 9.7% to \$62.1 billion in 2018, exceeding the historic high of \$56.6 billion set last year. The equipment market is expected to contract 4.0% in 2019 but grow 20.7% to reach \$71.9 billion, an all-time high.

30+ YEARS EXPERIENCE. MORE THAN 30 PATENTS. JUST ONE GOAL.



**Flexible
Printed Circuits**

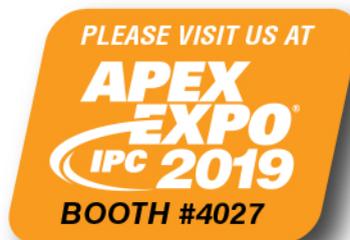


**Flat Flexible
Cable**



**Wire
Harnesses**

Providing a quality, cost-effective solution on time has been our goal since day one. We achieve this through unparalleled customer service and by designing, sourcing and finishing interconnection systems for our customers worldwide.



Miraco, Inc.
Manchester, NH
miracoinc.com
603-665-9449



MIRACO



Stephanie Martin: Component Supply Challenges From the Catbird Seat

Feature Interview by the I-Connect007 Editorial Team

Vexos Senior Vice President for Global Supply Stephanie Martin gives the I-Connect007 editorial team a wide-ranging and insightful overview of the current parts supply situation from the perspective of procurement at a contract manufacturer.

Stephen Las Marias: First, Stephanie, can you please tell us more about Vexos and your role at the company?

Stephanie Martin: Yes. I'm the senior VP of global supply for Vexos. Vexos is a high tier-three, low tier-two contract manufacturer. It is a combination of two different companies that were purchased by Center Lane Partners, a private equity company; EPM based out of Markham, Canada; and STACI Corporation based out of LaGrange, Ohio. We have four facilities that do contract manufacturing.

We have the Markham facility, which focuses more on high tech, fine pitch. Then, we have the facility in LaGrange, Ohio, is the Cleveland area that does medical, some automotive, and lower-tech products. We have two facilities in China: one in Shenzhen, which usually matches what Markham does—more fine pitch and higher-tech products—and one in Dongguan, which does automotive, medical, a lot of lower-tech products, and quite a bit of other manufacturing that is not based in electronics.

Then, we have another portion of our business we call the “custom material solution.” We are a trading company and represent a number of supplier partners for custom-built products like PCBs, cable assemblies, displays, heat sinks, metal fabrication metal machine parts, and plastic injection molding. We believe we're the only tier-three player in our space that offers not only a global solution but a full spread of components where we can supply everything from the outer housing, whether you do the electronics assembly or not. We can



SUPER DRY[®]

Totech EU[®]

More than just dry air

PLEASE VISIT US AT
**APEX
EXPO
IPC 2019**
BOOTH #2122



Humidity Control Solutions for Every Application

(512) 308-9700

www.superdry-totech.com

supply the PCBs all the way up to the full box build for you.

Las Marias: From your perspective as an EMS provider, what are the greatest challenges that you face or that you experience when it comes to supply chain?

Martin: Well, we're in the super-cycle for allocation, so we're heavily into the supercycle that we're dealing with. It started with the memory product, which we're coming up on three years now. And then last summer, around this time, MLCCs started getting tight. By November, we were in full-board allocation. We struggle like all EMS companies, particularly with MLCCs. The lead times are over 52 weeks with most manufacturers, if they will even take orders.

The second- and third-tier manufacturers will no longer cross your components, and for distributors, the inventory position is low. So, it's a challenge every time we get an order to find the MLCCs. We're also seeing tantalum shifts. A lot of those are now going on allocation. We have MOFSETs across the board that are running on full-board allocation over 40 weeks. Then, we have IGBTs and TV, Zener, and Schottky diodes, which are all in the 38-week range.

In the resistor arena, we have the Vishay CRCW series at 80 weeks now. The Panasonic ERJ series are at 40+ weeks. Generally, all mainstream resistor manufacturers are now 26–29 weeks. It has become quite a challenge. We spend a lot of time talking and working with our customers trying to get them to approve alternates quickly so that we can find materials and expand their AVL, and we spend a lot of extra time sourcing trying to just find inventory. It has become quite a challenge in this market.

Las Marias: You mentioned supercycle. Have you experienced this sort of extreme shortages when it comes to electronic component supply before?



Stephanie Martin

Martin: I've been in electronics since 1989, so I've been in it a long time. I've been through a number of cycles. I believe this is the tenth inventory cycle that we're in from what I can tell. The closest that we've ever come, and the last time we went into a shortage situation that affected passive components, was in 1999 right before the dot-com crash. At that point in time, we had problems with panels and capacitors. That's the last, and in my career, the only time that the passive products have been an issue.

Typically, the market follows some new must-have device, whether it was a pager, cell-phone, or laptop computer. This market cycle is very different. This one is not any single device. This market segment is really what we're calling "the electrification of everything." There's a huge change going on. A lot of pieces of our life that were never electronic are now becoming electronically connected to our phones and smart devices. We even have one customer that we're talking to that wants to make furnace filters smart, so they remind you to replace them.

All of the devices, including IoT, smart devices, automotive content, and cellphones are hitting us at the same time. No one device will fix the market once it's satisfied. The only thing I believe is going to fix the market is when we can get some increased capacity through new manufacturers coming in. There's also a technology shift happening, which appears to be very close to what happened back in the mid-2000s during the RoHS time where we switched from leaded to non-leaded parts; this one is going from larger to smaller case sizes.

If you look at a 1206 capacitor, they can get approximately 80 0402 capacitors in the same space or 300 0201s. As the market is tighter, I believe the OEMs are going to be forced to redesign to smaller and smaller parts, and that will allow the manufacturers to produce more parts in the same footprint that they had before. I think that's more along the line of what's going

to happen. All the projections that we get from the manufacturers and the distribution channel tell us that the market will not see a relief until mid-2019 at the earliest, and several of them say it will be towards the end of 2019 for MLCCs in particular.

A number of things are going to happen. The Chinese are bringing up some new fabrications. Several manufacturers are pulling some of their fabrication back in-house, particularly in the U.S. Some third-tier suppliers are coming in and starting up, particularly in Asia. There are a lot of things happening, but it will take a while for the market to level out.

Dan Feinberg: I have to agree with you on the supercycle. It's the largest I've seen since 1960–1962 when we switched from point-to-point wiring to circuit boards. The industry was much smaller, and the demands were much smaller and less widespread. Some of the things that I'm seeing, and hearing, is that this supercycle may last considerably longer than 2019 because it's a supply and demand thing.

With such long lead times, and you've answered part of this, are you planning or expecting new facilities to come on board throughout the supply chain, and where? With the tariff issues coming on, it looks like this is going to be more serious than people had thought or hoped, at least in this industry. While the overall U.S. economy will probably benefit from it, this industry may or may not. These could be significant tariffs and could last for quite some time. Has that switched or changed where the expansions that have been planned may happen?

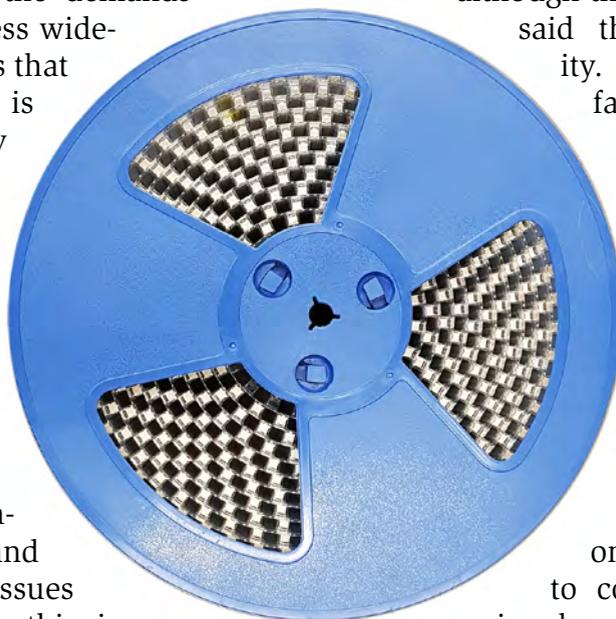
Martin: Let me answer that in two parts. The tariff issue is a whole different issue that we can discuss. When I've met with several manu-

facturers, I've visited the Vishay and Agile factories and several others in China and met with the Murata reps directly, so I've had quite a few conversations. The general feeling that I get or what I understand is that the parts that are in the greatest demand are what we would have called popcorn parts—the really low-cost penny parts. Over time since the dot-com crash in 2000, the prices have been depressed to the point where they're very low margins for the manufacturers, making their average selling price not profitable for them.

Feinberg: It's not attractive for expansion.

Martin: Yes, not attractive. So, it's unlikely that manufacturers will come in unless they're third tier, which would likely be in China. We're seeing a few third tier pop up in China, although they will not quote us. They said they're already at capacity. None of the main manufacturers that I've talked to are expanding in the larger case sizes. They are expanding in the 0201 and the 1005 case sizes, but they are not expanding in the 0402 and above. That's where most of the industrial sector is still located—in the larger case sizes. I think the only real relief that's going to come for those part sizes is when the OEMs decide to do a redesign into the smaller sizes.

Now, from what I also understand, these larger case sizes probably have no more than 0603 and up. They probably have no more than a three- to five-year lifecycle. When the automotive industry phases them out, I believe most of them will be gone, so that's what's going to drive it. We've been told that a current automobile has about 3,000 MLCCs in it, and an electric vehicle has 30,000 MLCCs. When they go through with this tight market designed to the smaller 0201 and below, then I





totally. Have you heard of any that are considering doing a little of that?

Martin: Yes, we've heard some pulling it on the semiconductor side. Now, the MOSFET MLCCs went on the semiconductors like the MOSFET-type products. We've heard that a couple manufacturers are pulling some back in; some CMs may be pulling some but in smaller amounts.

The other problem that we're hearing is that the three main fabrication manufacturers sitting in Taiwan are experiencing ingot shortages, so they're having some supply problems on their end. I just read a notice on

think you'll start to see relief and the few players that are left will be able to pick it up. But, in the larger case sizes, I don't see much new capacity coming on in those.

What we're doing in that sector is working with our customers. We're doing BOM analysis for them and giving them options for crossing. I'm meeting with a lot of them personally. We're encouraging them to look at redesigns based on the lifecycle of their products to make sure that they have coverage for their end-of-life parts. Murata put out a notice earlier this year on end-of-life a lot of parts; March of next year is the last buy. When that hits in March, there will be a big flood, and I believe the lead times will move out further than they are today when all the customers that haven't acted realize that they're not going to get these parts. Murata is the biggest player and has somewhere between 30-40% of the global market share. We've already received notice from other manufacturers like Temic and ABX that they're not pulling out of those parts, but that they can't handle the additional requirements that are going to be coming at them. So, I believe there's a major problem coming the first of the year.

Feinberg: I've had a few very slight indications that there are a few OEMs considering doing what was done back in the '60s and '70s and starting to do their own fabrication and assembly. That's something they went away from

TSMC, the largest, that they brought a new machine online. The machine had a virus, and they lost their whole run of wafers; it delayed the ViaLinks parts until the fourth quarter, so there are a lot of them. I think everybody's trying to go through the same type on the semiconductors so that they can pull those back in-house—probably easier.

Yageo, when I was there, told us the resistors are experiencing raw material issues, which may be driven by the Chinese environmental requirements that they've put in. They've been closing quite a few of their suppliers due to water and air purity requirements. They've had issues with the metal, paper, and substrates that they use. They've had quite a bit of issues just getting raw materials for the resistors. Yageo is your biggest resistor manufacturer, and Murata is your biggest capacitor manufacturer, so there are levels of supply chain issues all the way through. There are raw material and capacity issues. They're moving to support the higher needs of the automotive and handheld sets. They've shifted lines down away from the industrial sector, and there are a lot of different things happening all at the same time.

Feinberg: There's even a tremendous difficulty for getting laminate. There are long lead times for PCB fabrications to have laminate just to make the circuit boards.



AVOID~~THE~~VOID[®]

*because sometimes small problems
create big issues.*

ACHIEVE
LESS THAN 10%
SOLDER VOIDING

techsupport@indium.com
www.indium.com/avoidthevoid/SMUS

See us at IPC APEX, Booth 3133

©2019 Indium Corporation



Martin: We had that problem last summer where they couldn't get the foil sheets to build the laminates because they were going toward batteries and electric vehicles. We haven't had a lot of fabrication issues recently. Most of our suppliers in China are back to near normal lead times—about six weeks for those. They had jumped up to over 10 weeks last summer, and prices escalated. The prices have come back down and stabilized a little bit and the lead times dropped down. Most of those, at least with our suppliers, have been fixed on that end. However, we continue to run into trouble with passives, resistors, capacitors, and discrete items like MOSFETs, diodes, and those types of devices. That's what's giving us a lot of hard work.

Barry Matties: Some companies anticipated the shortage for the capacitors and started stockpiling in early 2017—maybe even before. When you look out, what other shortages should we be looking at that people should consider stockpiling?

Martin: Right now, the resistors and MOSFETs are the next thing, which have just come up as being real problems (other than Vishay and Panasonic, which have been a problem all along). I think you're looking at the discrete items. Their lead times have jumped up a lot, which we're starting to see. We've had quite a few MOSFET issues pop up. I think those are

more short-term problems, though. I don't think those are going to be a long-term issue for this.

The tariff issue has just really made a bad situation even worse. We track the tariffs because we're global and deal with tariffs from all different directions. One of the things we found out was since we're primarily a distribution customer is that all of the distribution inventory is warehoused in the U.S. Even though Canadian companies warehouse all of their goods in the U.S., that makes them subject to tariffs.

In our China facility—because we have U.S.-based customers—there is special manufacturing pricing that can only be obtained if we buy it through the U.S. We have some programs that we still have to buy parts out of the U.S., which are now subject to the tariffs. List 1 caught the electromechanical and the LED—not the diode, but the LED. List 2 has pretty much caught all of the electronic components out there, so it's now affecting all of them. Through the distribution channel, they are working on mitigation strategies for Canada, Mexico, and China, so they won't have the tariffs pass through. We have three main ways the tariffs are coming at us. Right now, we know of 14 manufacturers who are the importer of record and are embedding the tariff increase as a price increase.

We've seen price increases on some components as much as 80%, so they're putting the price increase and tariff together. We have some parts that the distributors are the importer of record. They are mitigating most of those through doing a free-trade zone, duty drawback process, or utilizing a warehouse in Guadalajara, depending on who the distributor is. The last way the tariffs are coming at us is that the manufacturers are the importer of record. They invoice the distributors, who invoice us. In that case, where it gets complicated is that the manufacturers that are invoicing are invoicing at the book cost—not the debited or final cost.

Where you may have a special price for 75 cents, the book cost is \$1.00. You're going to pay the tariff on the



dollar—not the 75 cents—so it’s a real challenge right now. We are capturing the harmonized tariff and HTS codes on all of the parts. We ask for the country of origin when we place an order. And if we have an option to use a country of origin other than China, that’s where we’re going, even if the price is a little higher.

We are hearing that the manufacturers who already have sites outside of China are looking at rescheduling their business for goods based in North America to sites outside of China. We haven’t seen a lot yet, but we’re hearing it’s happening. For our U.S. facility, we’ll be very carefully looking at who the manufacturers are and where it’s coming from. If we have options to avoid this 25% tariff, that’s where we’re going.

Andy Shaughnessy: My readers are primarily designers. Let’s say you have a product coming out next Christmas in 2019. Other than stockpiling, how do you plan for the future? What should they do to try to get ahead of this?

Martin: When I meet with engineers, I tell them if it’s a brand-new product, design it in the smallest case size possible; 0201s and 0105s are your best bet. In those cases, if you can approve automotive grade, you have a better shot of getting parts. They tend to be a little higher priced, but you can still get parts in the automotive grade. If you can’t design it, you need to offer as many alternatives as possible. The worst thing you can do is come out with one sole-source part because you will ultimately have supply chain problems at some point, whether it’s today or later.

What we ask our customers to do before they stabilize and while they’re in the process of design is to let us analyze their BOM. We use IHS Connect software as a predictive modeler. What we like to do is work with them while they’re still in the beta stage. If you have a partner that you’re going to work with to outsource your product, you need to give them the authority to place parts on order as soon as you qualify them, so that you can at least get in the pipeline. It’s more successful to pull in parts once you have them pipelined than

trying to start from scratch and pull in parts to wait for lead times.

Somebody needs to put those on order. The reality is that unless there are non-cancelable, non-returnable parts, you can cancel or reschedule within 45 days typically without any problems. If they’re some of the really hot parts, you have no liability. There are a lot of strategies that you can go with if you have a design coming, but you have to think ahead on planning the supply chain.

Shaughnessy: It sounds like they just need to stay on the ball.

Martin: There’s no silver bullet.

Las Marias: When it comes to supply chain, one of the issues is counterfeit components. Now that the industry is facing this severe shortage, do you expect an increasing number of counterfeit components in the market?

Martin: Absolutely. That’s one of the things that we talk to the customers about. The grey market is actually drying up. A number of manufacturers have shut the back door for the grey market suppliers—the independents. Further, some distributors have shut the front door, so they can’t order from their sites.

The amount of inventory that’s still available through the grey market is getting tighter and tighter, which means your risk of counterfeit goes up.

The amount of inventory that’s still available through the grey market is getting tighter and tighter, which means your risk of counterfeit goes up.

We have a small set of approved independents that we’ve audited. Each of them has



Panasonic.com

Polymer technology, an MLCC alternative.

independent labs that they work with for quality checking. The distributors are now requiring that they are authorized to do destructive testing because of the high risk of counterfeiting. We haven't seen any counterfeit material yet, but we are very cautious and watchful for it.

Las Marias: What can you advise our readers when it comes to these issues in the supply chain?

Martin: They need to forecast. Even if it's not 100%, you need rolling forecasts for 52 weeks. We understand that customers do have that much visibility, but they need to give their partners as much visibility as possible. A 52-week lead time is pretty standard. Every BOM has components now that are over 40 weeks long—every one of them. That doesn't mean that we can't still find parts, but when the grey market, available inventory, and distribution channel dries up, there will be no parts. You'll be forced to wait for it. The customers who are in the best position are doing rolling forecasts. They update it monthly out 52 weeks.

When their partner gives them an alternate component, they need to approve it very, very quickly. Usually, if it's in the grey market these days, it's gone within 24–48 hours. If the customer takes a week to approve it, the inventory is gone. The next time we find it, the price may be up. I would suggest that they buffer critical stock components and authorize addi-

tional buffer stock on the allocated components. Then, look at a redesign for the smaller case sizes. If the lifecycle of their product has three to five years remaining, they may want to look at putting an additional buffer for the end of life. If their product lifecycle is eight to 10 years or more, then they really should look at redesigning the small case sizes so that they'll have sustainability.

Finally, they need to look at an alternate type of materials. On the MLCC, you can typically replace several ceramic chips with a tantalum chip. Although there are some lead time issues in tantalum, it isn't nearly as bad as ceramic, and there's the newer technology—the polymer. If they see their product is 35 volts or less, they need to look at potentially a different product other than ceramic. They can get a four to one placement on the polymers, but it only works if it's 35 volts or less. On the Vishay CRCW series resistor, if they can take the non-automotive temperature range, you can add a C to the end of the part number and those lead times drop to approximately 12 weeks from 80 weeks. There are a lot of things that they can do to help themselves.

Matties: Are there other strategies designers can use? You mentioned the lower case size, which makes sense, but are there other strategies the designers can employ to combat this?

Martin: Yes, if they generally just look for long-term production, there is a huge technology shift that's happening right now. We're at the beginning stages of it now. I think it's going to accelerate where the industry is going smaller. So, a designer needs to look at using the smallest size parts that they possibly can. Designers tend to use the parts that they're comfortable with. It is not unusual when we see a brand-new design that it has obsolete components.

That's one of the reasons we suggest to our customers to let us review their component list before they finalize the design. We can offer suggestions to them on alternative components given the same form, fit, function, and placement. It's designing for the supply chain. There are a lot of things that they need



How Intelligent Is Your Parts Counter?

Let me ask you, can your x-ray parts counter detect:

- Incorrect labels?
- Counterfeit parts?
- Missing parts?

No!?

Well, time to check the all new TruView™ Parts Counter AI. Yes, the AI stands for artificial intelligence. We needed a little extra help from AI to give you all that plus the ability to count four reels accurately, fast, and without the need to program anything. We know you've been waiting for this x-ray parts counter. The wait is finally over.



to look at designing for the long-term supply chain. More and more devices are going to become electronic, so the market itself is going to continue to expand, making it increasingly difficult to get larger parts. That's what I would tell designers.

Matties: Do you have designers on your employee list as well, and do you offer that as a service?

Martin: No, we work with outside services if a customer needs design. I have component engineering on my side that reports to me. We do a lifecycle analysis on the component using predictive modeling, and it's on a scale of one to five. I tell designers that unless you're in the leading-edge technology, you want to stay away from parts in lifecycle one. Those are brand new parts, and they're not accepted in the market. The prices are very high, and there are very few manufacturers.

I tell designers that unless you're in the leading-edge technology, you want to stay away from parts in lifecycle one.

If you're putting in a new design, you want to look for a lifecycle two to three and a half. A two means that it's starting to grow, more manufacturers are coming in, prices are dropping, and supply is higher. Lifecycle three is when the greatest number of manufacturers are there. It's at its lowest price point, and it gives you the largest supply chain opportunity. Once you start dropping below three and a half or four, the parts decline, manufacturers move out of the market, and prices go up. And, of course, five is obsolete.

If you're doing a new design, in the BOM analysis we do for customers, we show them

the lifecycle of the parts and say, "You have to know the lifecycle of your end item. How long and how does it match with the lifecycle of the components?" But if you're in a new design and looking at components that are already headed towards the declining stage, you will have supply chain problems.

Matties: You're right. Designers should be aware of this fact at the beginning.

Martin: In my experience, most of the engineers are somewhat insulated from the supply chain so that they really don't know the lifecycle of those components. However, it's probably the most critical aspect in a new design to make sure you have sustainability on it.

Matties: How many designers contact you with the BOM review before they do their designs?

Martin: We've been pretty aggressive at doing these BOMs. We do two things for our customers including a BOM health analysis, where we do the lifecycle of the parts and show them the MLCC situation. On those MLCCs, I'm crossing Murata's end-of-life list to all of their components by the voltage, microreference, and dielectrics. We tell them which are going to be their troublesome long-term parts, and we also do an inventory and bumper stock model where we pull in the market lead times.

When I do these with customers, it opens their eyes. With the customers that we've done it with, they push pretty hard on their internal design teams to be very aware of what's happening and get ahead of the curve. It is effective when it's done.

Nolan Johnson: From where you sit, how would you recommend the designers get more of that information? Obviously, once they're doing the analysis with you on what they think is their finished design, any problems may cause them to have to go back and do a complete redesign. Hopefully, it's not that serious, but that's sort of the dynamic that's getting set up here. If they can make better decisions in the design tool and give you a better BOM and design

with up-to-date parts, where should they go to be effective in that?

Martin: With most of the designers, the distributors call on them. That's where they get their sample parts and that type of thing. They should ask their distributors for the lifecycles because they have that information. They can use a software service. There are two of them: Silicon Experts and IHS Connect. Both are excellent software. The distributors themselves have this information and should work with their supply chain if they don't have it.

What I used to do a lot of was have lunch-and-learn meetings when I was on the OEM side. I'd bring in distributors. But in this world, and the way the technology shift is happening, they have to get ahead of this. It is not design as usual. As I said, there is a huge technology shift that is picking up speed. If they don't know the lifecycle of the components, they will be looking at major problems very shortly.

Feinberg: First of all, let me compliment you. You're extremely knowledgeable about your topics and very well prepared. It's just a delight to have this conversation with you.

Martin: Thank you.

Feinberg: The other comment I have is on the forecasting. One of the things that makes forecasting so difficult is that a lot of the companies, the OEMs, don't and can't always talk to each other. Therefore, they kind of take each other by surprise, which they should do if they're trying to compete. I think a good example of that is Apple has just announced a set of new iPhones that are truly amazing in design, but they got caught a little bit behind Samsung, who is pushing 5G at a rate much faster than anyone thought would happen. All of a sudden, everything could change in



the next 12 months on that end of the spectrum. This makes it difficult to do forecasting because the major pieces of information that would be very helpful with forecasting are being held very close to the vest by the big OEMs, as they should.

Martin: I can see that, particularly on some of your consumer goods. However, most of the types of products we work on are more industrial. They tend to have more forecast visibility. Most of them are not leading-edge technology. The handset industry drives the component market. Wherever they go, that's where the rest of us end up going too. But the rest of the customers—the industrial base customers—tend to have much more visibility or predictability than the latest designs. Most of them are not earth-shattering designs that come out. They're enhancements or improvements to what they've already offered.

Matties: Where are you located?

Martin: I'm physically located in Tampa, Florida. I work remotely and travel.

Matties: Good for you. We're a virtual company as well, so we have people on this call from all parts of the world right now.

Martin: I appreciate all of the attention we're getting, and I hope you find it helpful.



That's coming at us. And then, come 2019, I believe the lead time for the larger case sizes of MLCCs is going to go out further than it is right now. That's going to be a huge problem.

Matties: It's not just manufacturing capacity alone, it's actually a shortage of the equipment to produce them. There's not enough equipment as well.

Matties: Very much so. Is there anything we haven't talked about that you feel we should cover?

Martin: As I said, we're fighting tariff issues. We're mainly waiting for manufacturers to move. I think there's going to be a big move on business out of China to other regions to mitigate the tariffs. It hasn't really had a huge impact yet, but I think it's coming. I think it's going to have a significant impact in a few months. Right now, the distributors have been really good. They're absorbing what they can't mitigate for us, so it's going to have a huge impact with the manufacturers on what they choose to design and which products we buy.

Martin: Yes. I was at Vishay in China this June, and they told me they had equipment on order for a year, and they had pushed it out because the manufacturer couldn't get parts.

Matties: It's a deeper supply chain issue beyond just the floor space.

Martin: Exactly. The manufacturers can't get the machines to make more parts because the machine manufacturers can't get the parts.

Matties: Thank you very much, Stephanie. This was very informative.

Martin: Thank you. SMT007

Electrolube on Managing Thermal Interfaces and Conformal Coatings

At the recent electronica show in Munich, Germany, I-Connect007 Technical Editor Pete Starkey met with Jade Bridges, global technical support manager at Electrolube, to discuss how to manage thermal interfaces for maximum heat transfer efficiency, and the latest developments in their thermal management materials. She also provides an update on conformal coatings, and the trends they are seeing in the market.

"The LED industry is one we've focused on a lot where efficiency is key. The automotive industry is another important area—basi-

cally, anywhere they need good heat dissipation. Electric vehicles are a key example in the automotive industry, as well as battery packs," said Bridges. "We've looked at

the requirements of these industries and how they differ from what we were doing 10, 15, and 20 years ago. It's a growing market, and the range of applications is expanding, so we decided to invest in a thermal management specialist team that solely concentrates on that area. We have chemists developing new technologies and making our current technologies even better."



Jade Bridges



Whether you are an
EMS, CM or OEM,
let our bare boards be the foundation
you build your reputation upon!

Technology:

Up to 50 Layers
Any Layer HDI
Sequential Lamination
Blind / Buried Vias
Laser Drilling / Routing
Heavy Copper

Materials:

Fr4
Metal Core
Isola
Rogers
Polyimide - Flex
Magtron

We will make only what is needed,
when it's needed,
and in the amount needed.

You no longer have to worry about long shelf life
or tie your capital in bare board inventory.

Accutrace inc.

www.PCB4u.com sales@PCB4u.com

SAM & ITAR Registered UL E333047 ISO 9001 - 2008

Whether you call yourself an EMS, CM or simply a Bare Board Assembler,
Accutrace has you covered.

Sunstone's Matt Stevenson on Supply Chain Issues in Quick-turn Fabrication

Feature Interview by Barry Matties
and Nolan Johnson
I-CONNECT007



Barry Matties and Nolan Johnson talk supply chain trends for traditional board fabrication houses. High-mix, low-volume manufacturers can often be looked to as bellwethers for the industry. Matt Stevenson, director of marketing at Sunstone Circuits, shares his take on the current market.

Nolan Johnson: Matt, we wanted to chat with you to get some deeper background on issues around the supply chain from a fabricator's point of view. As you're probably aware, a lot is going on right now in the industry, especially around components and manufacturing. Major industry sectors like automotive, military, medical and cellphones seem to be driving the supply chain for components and availability in some pretty huge ways. We hear this a lot from contract manufacturers. What's Sunstone's perspective on the supply chain issues? How are you seeing them affecting the fabricator's daily life?

Matt Stevenson: From the PCB fabricator standpoint, we haven't yet seen any direct impact from the part shortages. However, when we

do have the opportunity to quote a full turn-key type of job for customers where we use Screaming Circuits, our contract partner, we do see delays and issues in getting those quotes turned in a short amount of time, as well as not being able to quote the entire BOM in any feasible manner. So, we are seeing some issues with customers having to try and source parts themselves, especially the caps and ceramic parts that are causing a lot of the issues. Our assembly partner looks at the main catalogs of Digi-Key, Mouser, and a couple of their other approved component distributors. They have not necessarily searched high and low on all the boutique distributors to see if they can find it there in their process. Sometimes, this can lead to dialogs with a customer because they can find the part in question with a Google search, but have they vetted the legitimacy of the supplier or where these parts originated?

Barry Matties: Matt, have you noticed a reduction in the quote volume? Because we're hearing that some people are just slowing their processes down in terms of even ordering boards because the lead times are so great.



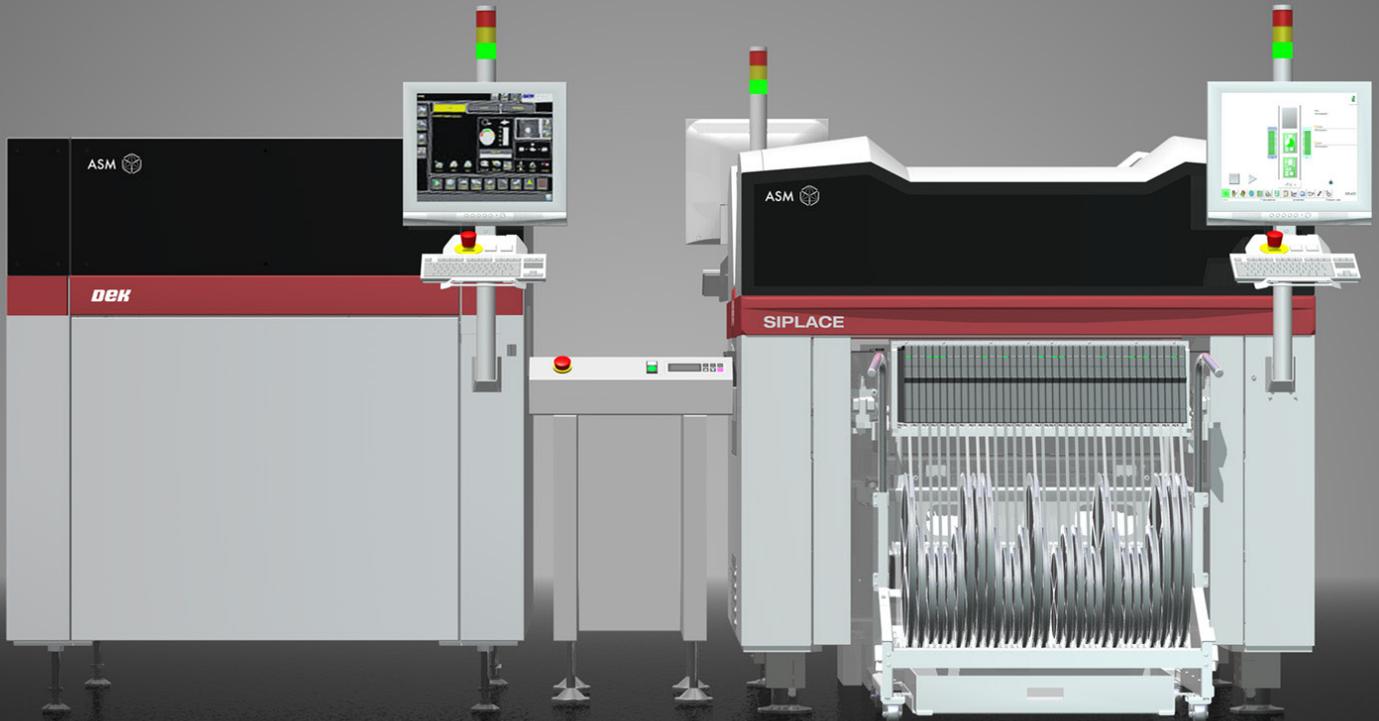
TECHNICA, U.S.A.

Fulfilling Manufacturing Needs Throughout the Electronics Industry



E by DEK

E by SIPLACE



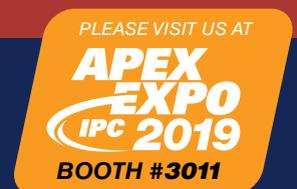
- Fast setup & changeover
- Simple operation
- Stable & reliable print process
- Fine pitch printing capability
- Excellent print definition

- Powerful off-Line programming
- User friendly interface
- Exceptional pickup reliability
- 100% ball & lead inspection
- Optimal performance & accuracy

Excellent choice for High Mix, Medium Volume Production

ASM  **Assembly Systems**

Available in the United States exclusively through Technica U.S.A.
1-800-909-8697 | www.technica.com



Stevenson: We have not really seen a noticeable reduction in quote volume. We are still trending within the lines of our historic numbers for quotes received on a daily and weekly basis. We have seen some changes in customer behavior with the number of turn-key quotes, which has probably increased for us recently with people potentially trying to find a supplier who's able to actually do all of that rather than them trying to source parts here and boards there, and assembly over here.

Matties: That's probably becoming a much more demanding role; it sounds like they just want to ship that over to a single source.

Stevenson: Yes, and it seems like their tolerance for longer lead times, etc., has decreased as a result. A lot of the customers want a two-day board lead time, and they want a two-day assembly lead time. If it takes them four days to get parts, they're not happy about these kinds of things.

Johnson: Matt, is it fair to say then you're not seeing any impact on your fabrication raw material side?

Stevenson: Exactly. The components, tariffs, and all of the other things that have been going on in the industry affecting a lot of the electronics have not directly touched Sunstone. We do

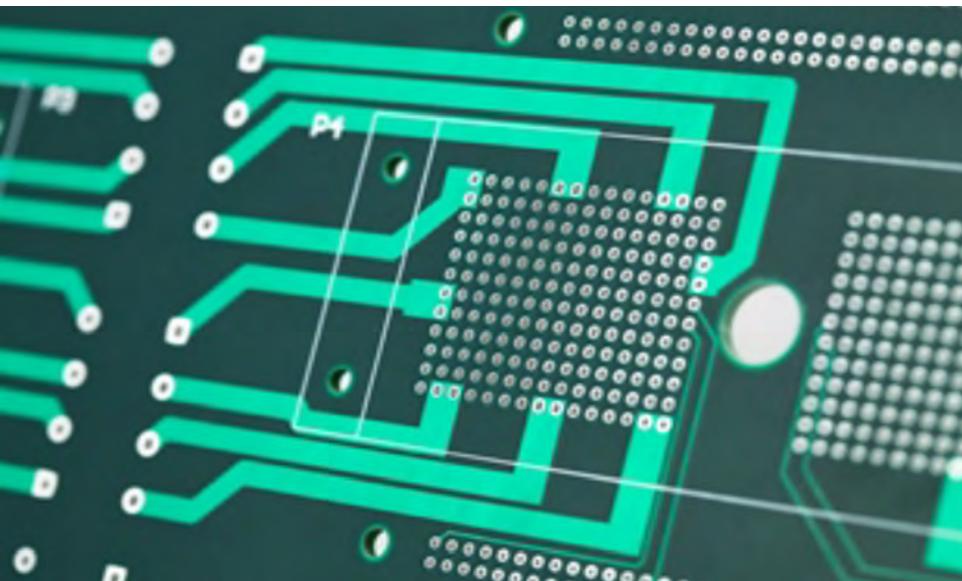
source some of our materials overseas, laminates, chemicals, etc., but at this point, all of our suppliers have either found a way around some of the tariffs (i.e., using Taiwan as their manufacturer), or if they do have to source some of their materials on Mainland China, they absorb the tariffs as part of their supply chain. They're honoring all of the contracts that they had with us without adding any additional processing or tariff-related fees. At this point, we're not really seeing our supply chain being affected by the tariffs and component shortages.

Matties: What about the lead times for your laminates suppliers? Is that an issue associated with some of the high-speed stuff?

Stevenson: The high-speed stuff has been a problem since before the tariffs, etc. It's been about a year since Rogers, our main supplier of the high-speed stuff, had a lot of the duroid materials go to 50- or 75-day lead times. As a result, we had to start ordering ahead of time on those materials that we knew we were going to use on a regular basis. As far as our FR-4 laminates, we haven't seen any changes. Our suppliers usually stock a pretty fair amount domestically, and then they have their own processing facilities, so they can press materials as needed and are not held hostage by longer lead times in Taiwan.

Matties: Rogers is one company that has a notable long lead time. Now, we're seeing other suppliers come in with new laminates that they're calling drop-in or replacement laminates. How does that work in the supply chain there? Is this something that you can recommend to your customers, or are they just bent on having a particular brand regardless?

Stevenson: We can do some, and we have done some recommendations as far as using



another supplier that has one of these drops in laminates. But it really needs to be driven from the OEM and customers to the laminate suppliers. They put numbers on their prints calling out a specific laminate, especially in the high-speed stuff, and they don't want substitutions. They've done their modeling and testing at that specific material, and the line, width, spacing, arcs, and everything are done directly with that that DK in mind as well as the dissipation factors, etc. They are not really willing to do a lot of substitutions.

That being said, we are in the midst of doing some exploratory surveying with some of the people especially in the RF type of industry to find out what their overall tolerances are when prototyping for using these other materials. Is close good enough for prototyping as opposed to their production builds or their preproduction? We want to find out if we can start pushing some of those other types of laminates from a prototype standpoint and get the engineers a little more comfortable with using some of those other laminates up front in their design process.

Johnson: Matt, would you go so far as to say that maybe there's some improvement in the supply chain for your materials?

Stevenson: I would say we haven't seen any change, positive or negative on our core laminate FR-4 type materials. Pricing, lead times, and availability have been the same for us. Rogers is getting a little bit better. Some of those 70-day lead times have come down to 50 or 35 in some cases, but they're still pretty expensive. We still have to really plan ahead. So, I wouldn't say that things are improving a whole lot, but there are signs of them getting better.

Matties: When you look at supply chain management, what do you think is the greatest challenge overall for PCB fabricators?

Stevenson: For a fabricator, I think we're a little at the whim of the designers depending on what their supply chain challenges are.

We have seen an uptick in shorter lead time builds based on the struggle of sourcing parts, and when they finally source the parts, then they're in scramble mode to get everything built before they do a respin or something to change component footprints or values on their part. As far as materials go, we've been pretty much unaffected at this point. Our transportation suppliers have been good. In fact, we're getting some reductions in our freight and transportation costs going forward.

Pricing and availability for laminate materials haven't really changed for us a whole lot over the past year. Chemicals have been readily available, so Sunstone hasn't seen much of an impact thus far from any of the challenges in the supply chain.

Chemicals have been readily available, so Sunstone hasn't seen much of an impact thus far from any of the challenges in the supply chain.

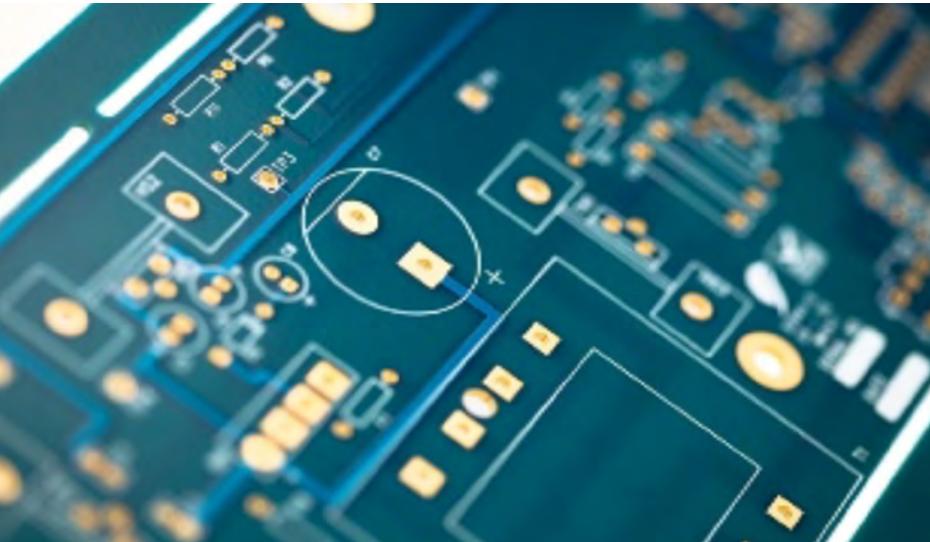
Matties: When people are ordering or working on their boards, how often do they communicate with you before ordering? Or do they simply give you the design and wait for a quote?

Stevenson: The vast majority of our customers don't communicate with us up front. Sunstone's reputation and business model has been, "Submit your completed files, and you'll get what you ordered." It's a great model for prototyping and speed of delivery. As we continue to increase our engineering staff and expertise along with our manufacturing capabilities, we are seeing a slight shift in customer behaviors. We're getting some customers that have really adopted some of our technical resources as go-to people. But the vast majority of them still just submit their designs in

a completed fashion and then expect quality boards on time when they want them.

Matties: Now, part of the supply chain challenge that we see and have been talking about is the quality of the data that a designer provides a fabricator. Often, we're hearing that 99% of the required data that a fabricator needs is not provided, and that to even get a quote, there's a lot of communication that has to go back and forth to get this data. Do you experience that as well?

Stevenson: Not at that type of level. For the majority of our incoming quotes and orders, we have the majority of the data available for us to manufacture the boards from Gerber and drill files, netlists, etc.



Matties: So, are you saying that they supply you all the drill files, netlists, and everything that you need when they first submit for quotes?

Stevenson: The majority of them. There are some that will do just a fabrication drawing and request budgetary quoting. There will also be others where the majority of the files are there, but they may be missing a solder mask or silkscreen file, etc. But generally, when our customers approach us for a quote or an order, their file sets are in pretty decent order.

Matties: Are you saying that they're mostly 100% complete?

Stevenson: More often than not.

Matties: That's interesting. Why is that?

Stevenson: Now, that doesn't say that they're 100% accurate and that we can just go and move forward directly with those set of files. Sometimes there's conflicting information with what they've asked for and what they've provided.

Matties: Of the data that you get, how many of that 100% are incomplete or not accurate?

Stevenson: We probably put somewhere in the neighborhood of 25% of all of the orders on hold for one reason or another due to the files. That could be something as simple as, "You didn't order a cut-out, but I see three in your design file. Do you want those?" It could also be that their print says ENIG, and they ordered tin-lead. The files themselves could be completely accurate, such as they just didn't represent it properly in their order or request for a quote.

Matties: When you do get a file that's inaccurate in terms of meeting a cycle time, how much impact will that have on cycle time?

Stevenson: Typically, Sunstone has tried not to have those holds impact the lead time on an order, but that really depends on how responsive the engineer is to the hold request. If they're able to update their file and send it to us within the day, generally, that's not going to impact the lead time unless we're talking one-day lead time as it is. Overall, we try not to pass that on unless it is something that's a multiple-day delay or really changes the scope of the order.

Johnson: Does that attention change once you have a customer that's moved from more of a "run-as-sent" order to a more production order with you?

ELIMINATE SOLDER DROSS AND REDUCE YOUR SOLDER SPEND BY 50% !!!

Significantly reduce your solder bar spend by **over 50%** when you use **MS2[®]** along with the *revolutionary* and affordable **AKILA** dross recovery unit.



ISO 9001:2015



Visit us at:

**APEX
EXPO[®]**
IPC 2019
Booth 3300

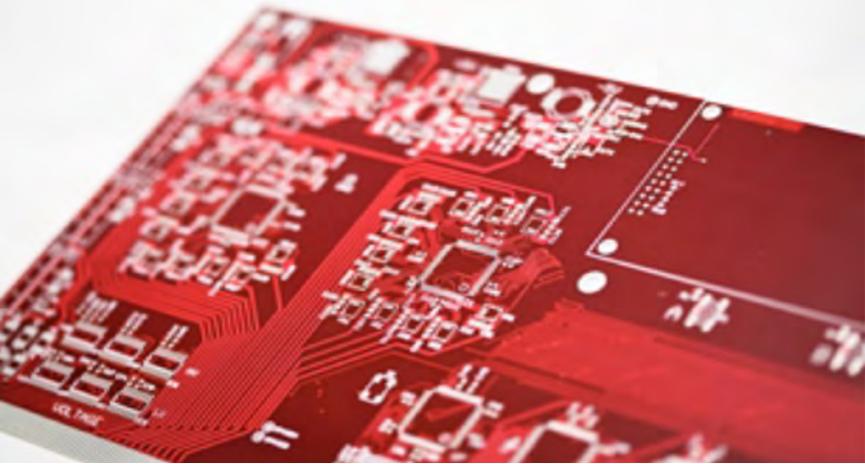


MS2[®]
Molten Solder
Surfactant

pkaymetal.com

+1 323-585-5058

PK
M·E·T·A·L



take advantage of that on some higher layer counts where they're prototyping.

Density is getting tighter on that type of product, some of it's probably due to changes in our pricing model. They're able to get those tighter pitch parts through our run as sent services where that required a full NRE build, etc., before. So, we are seeing a shift towards tighter pitch, smaller holes, more surface-mount components, and a lot fewer through-holes. If you look at our product overall, some of that is our own doing—we've done it by design—

Stevenson: Yes. When the amount of stringency on the order increases, then we do need a little bit more time on average to make sure that the customer is getting what they had intended. As a run-as-sent product, we're able to accelerate those through the shop. We can eat 12 or 24 hours of hold time and not have it impact those orders. But when the scrutiny on the manufacturing floor has to be a little bit higher—like we're looking at print notes and customer specifications, and they're actually looking for IPC-6012 Class 2 or 3 requirements—then we do need to pass the time on to the customer, especially on the shorter lead times. On a three or two week, generally not, but with something that's a week or less, we may have to add a day here or there depending on the holds.

Matties: What trends are you seeing in the technology in terms of what people are ordering? Is it growing in density or is it layer counts?

Stevenson: Our run-as-sent service is kind of a model where, "Just send us your files, and we'll build what's there. We're not going to scrutinize the design or manufacturability." If you have a three- or four-mil trace, we're basically going to build it as is, and the outcome may not always be perfect for those parameters outside of the service capabilities. That type of product has remained relatively unchanged over the last few years. About two years ago, we did open up the layer count from a six-layer to a 14-layer maximum, and we have seen people

and some of it is the industry and where things are going.

Matties: In terms of your manufacturing processes, what sort of investment in technologies are you looking at right now?

Stevenson: In 2017, we spent a lot of money on equipment. We bought an LDI. We upgraded our soft gold to accommodate a lot of the RF products. We updated our ERP and websites, etc. We added a new Orbotech AOI this year, which has been great.

In 2019, we have several capital equipment purchases scheduled already to help elevate our current technical capabilities as well as update our existing processes. But we have noticed that more and more high-speed designs, even these short little lines, require impedance control to keep the clock times accurate without the signal-loss and bounce-back effects. So, we are upgrading our technology there for 2019.

Matties: So, that's a trend that you're seeing on the types of products being ordered?

Stevenson: Exactly. There are still quite a few prototypes and designs that don't require controlled impedance, but it is becoming table stakes if you will.

Johnson: That's why there's a move to more high-speed type designs throughout the industry.

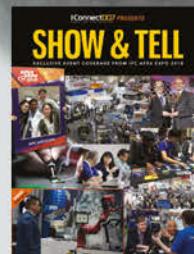
Get connected.



I-Connect007.com/register



Connect with us:
Booth #3119



Stevenson: Yes, even using classic FR-4, which can be done, they still have to control those line widths and impedance.

Matties: It's certainly significant enough for you to invest quite a bit of money on the technology.

Stevenson: Yes. When we started this project, an engineer involved said, "We just need to implement a quick testing solution." We did some further research and determined if we're going to do impedance, we have to go all the way in. We have to have the upfront modeling and feedback from our manufacturing floor on press thicknesses of dielectrics and line width tolerances, shapes, and TDR values, and we need to etch to impedance. We no longer expect engineers to model to the tolerances and hope the impedance is going to come out at the end. We need to be proactive and make sure that we're adjusting line widths as needed to make those impedances happen rather than just testing and hoping.

Johnson: That might circle back around to having orders and conversations with your customers. More complexity in this area could increase the number of holds and conversations you have to have.

Stevenson: Exactly. We're going to have somebody up front that is very well versed in impedance and able to have those conversations intelligently with our customers to make sure that we're getting what they need. It may also impact our cost of goods sold and our overall inventory levels having to carry more laminate and prepreg thicknesses, different resin contents, etc., to be able to really optimize impedance for these customers.

Matties: Thank you for your time today, Matt.

Stevenson: Thanks for the opportunity.

Johnson: Thank you. SMT007

Dr. Traian Cucu Discusses Low-temperature and Lead-free Soldering

Dr. Traian Cucu is the group leader of the Global Applications and Technologies Expert Group (GATE)-R&D-at Alpha Assembly Solutions. In an interview with I-Connect007 Technical Editor Happy Holden, Dr. Cucu discussed low-temperature and lead-free soldering applications and advantages, and their recently published I-007eBook on the topic.

According to Dr. Cucu, everyone in the assembly industry is looking at low-temperature and lead-free soldering for the many critical advantages that can be achieved by moving to a low-temperature process. "The lower thermal energy that goes into a process allows for less mechanical and thermal stress on the components, which will have an impact on the long-term performance and life of the device itself automatically. Again, the lifespan of an assembly

will have an impact on the bottom line for all manufacturers," he said.

Dr. Cucu explained that there had been a lot of work done in the past couple of years on the first generation of low-temperature alloys. "Now, we are seeing the second generation—we might call it the second wave—of low-temperature alloys, and the third generation, which is looking to improve on those further."

With the second generation, the industry is already close to the performance of the joint mated with a low-temperature alloy and that of a SAC alloy, according to Dr. Cucu. The third generation is already looking to improve even further for more benefits—including mechanical and thermal—on top of all the advantages that we see by moving to a low-temperature assembly process.

[Source: Happy Holden, I-Connect007]



Dr. Traian Cucu



**APEX
EXPO[®]
IPC 2019**

IPCAPEXEXPO.org
#IPCAPEXEXPO

TECHNOLOGY'S FUTURE COMES TOGETHER

SAN DIEGO CONVENTION CENTER, CA, USA

A future that drives success for the entire electronics industry becomes reality when the industry comes together. Join your peers and colleagues to learn, share knowledge and push the boundaries of technology.

Plan now to be in San Diego for **IPC APEX EXPO 2019**.

MEETINGS AND COURSES: JANUARY 26–31, 2019

CONFERENCE AND EXHIBITION: JANUARY 29–31, 2019

Thank you to our **IPC APEX EXPO 2018** volunteers, supporters, sponsors, exhibitors, instructors, speakers, committee leaders and committee members for an outstanding event.

No Rest for the Weary: Supply Chain Pressures Are Here to Stay!

Feature by Jamey Mann
KIMBALL ELECTRONICS

As we leave 2018 behind, it should be noted that the challenges faced by all consumers of electronic components in our industry this year have stretched teams both physically and mentally. We will continue to see pressures across the supply chain through 2019 and beyond, so there is no rest for the weary. Companies that fostered relationship growth and partnerships with the supply base when the market was tilted more to the buyer's favor are proving to be more successful in attaining support during the current under-supply conditions. The true test of a partnership can be examined when the market is out of balance. Relationship management should not be a tool used only when convenient or in need but developed as a core tenant of any successful supply chain management philosophy.

It is highly suggested to have your supply chain management team work very closely with both the customer and the supplier base to ensure that a minimum of a full year of demand is covered. There is little to no ability for the market to absorb demand increases within this period. It is also highly suggested that you work closely with your customer to eliminate single-sourced commodity compo-



nents as a single source limits flexibility in the supply chain solution. The bottom line in this type of market is you must communicate often and thoroughly to ensure your needs are not only understood but also acknowledged.

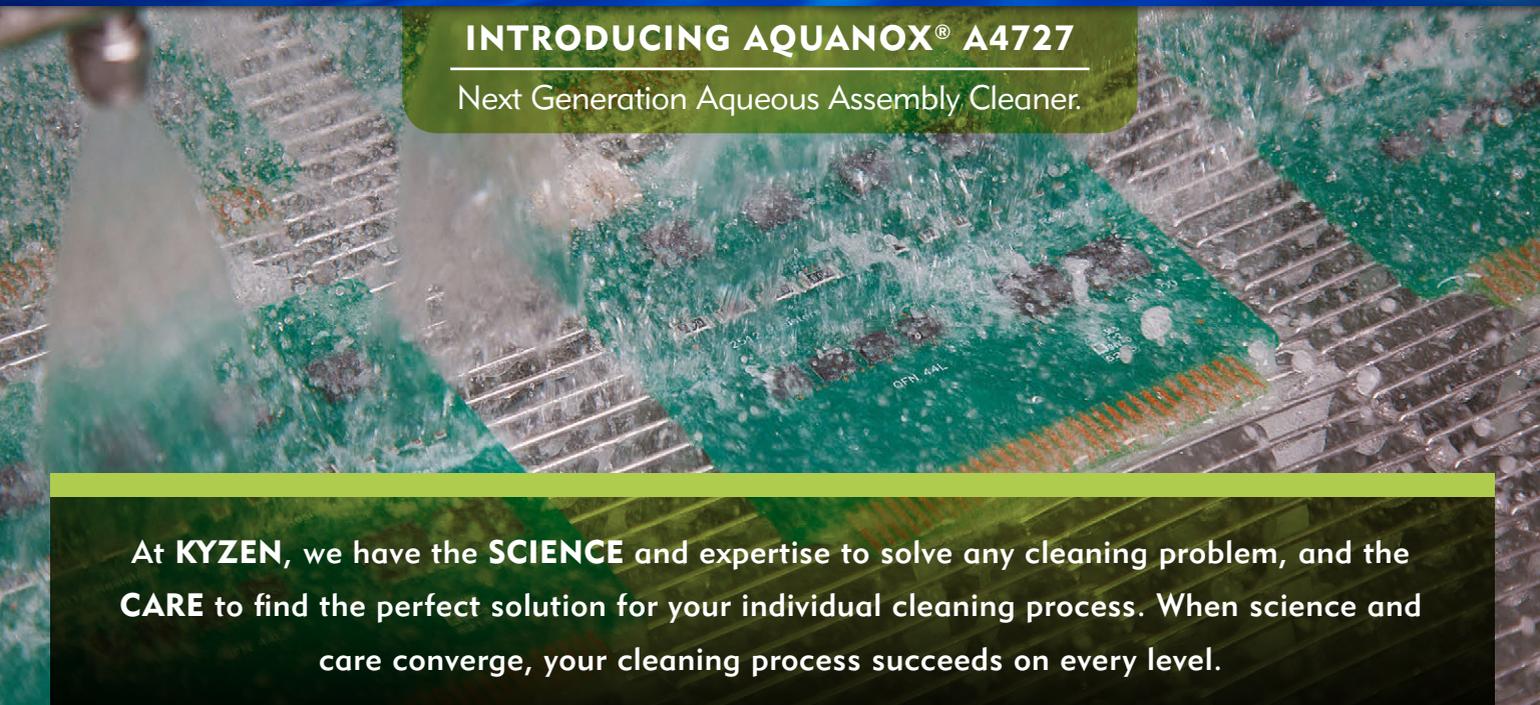
Why Are We so Challenged?

The overall electronic component market remains in a state of under-supply related to many subsets of component categories. After years of continuing pressure of decreasing prices in a range of 4–8% per year, the market finally hit its breaking point in late 2016 and into 2017. Many suppliers delayed adding new capacity expansion due to the reduced profitability driven by the continuous pressure on price reduction coupled with an over-supply market from 2011–2016. When you combine this lack of capacity expansion with greater electronic content within today's markets and account for the expansion of all global economies, you create a perfect storm of events that has led us to the market today where long lead times, constraints, and allocations prevail.



The right solutions happen when
you care enough to ask the right questions.

INTRODUCING AQUANOX® A4727
Next Generation Aqueous Assembly Cleaner.



At **KYZEN**, we have the **SCIENCE** and expertise to solve any cleaning problem, and the **CARE** to find the perfect solution for your individual cleaning process. When science and care converge, your cleaning process succeeds on every level.

Go to KYZENSneakPeek.com to find out more about the new Aquanox A4727.



KYZEN.COM

WORLDWIDE ENVIRONMENTALLY RESPONSIBLE CLEANING TECHNOLOGIES

This three following items will provide a high-level summary of some of the key constrained and allocated components.

1. Multilayer Ceramic Capacitors (MLCCs)

Due to underinvestment on the capacity side as previously mentioned, along with increased content requirements of today's electronics, the majority of manufacturers in the MLCC space are operating under allocation rules. Even as many of the major players in this market are currently adding capacity that equates to an approximate 15% increase in output, the market is projected to remain allocated through 2019 and into 2020. Book-to-bill ratios are still running in the range of 1.5:1. Suppliers have also instituted price increases that range from 9–300% effective on all new deliveries after their respective increase announcements. These manufacturers have eliminated special contract pricing to franchised distributors as well, leaving them to buy at book costs, which is causing price increases in the range of 20–500% to the market. Some manufacturers are setting pricing at the end of each month, quarter, or as material becomes available.

2. Thick- and Thin-film Chip Resistors

Much like the underinvestment seen in capacitors on the capacity side, thick- and

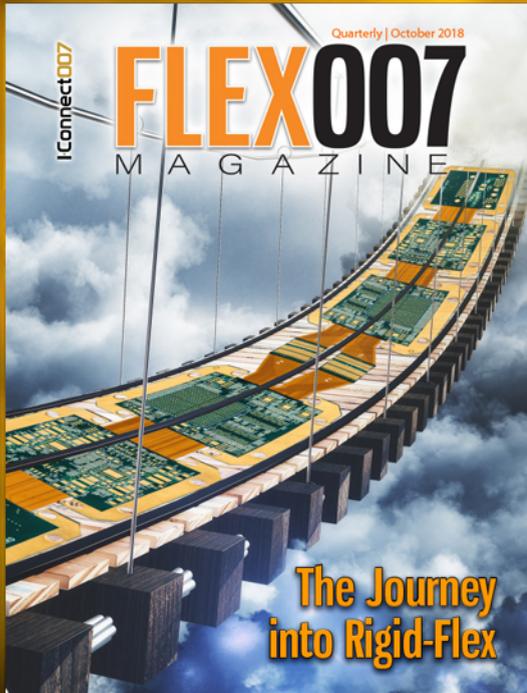
thin-film chip resistors fall in the same situation. Along with increased content requirements of today's electronics, the majority of manufacturers in this space are operating under allocation rules. Bookings continue to exceed output with no improvements seen into 2020. Price increases began in November 2017 and persisted through the summer. Increases range from 10–25%. Distribution is also forced to buy at book prices, which inflates prices to their customers.

3. Power Discretes, Mosfets, and Diodes

Raw materials for the backend have had a profound effect on component availability along with delayed capacity expansion within this commodity space, increasing demand, and availability of backend, package, and test capacity. Lead frames and packaging materials also have long lead times or are allocated. Most manufacturers in this space delayed capacity expansion until it was too late to react. Lead times range from 30–52 weeks to allocation depending on the manufacturer and component. There has been significant investment in capacity expansion; however, availability of electronic equipment has slowed the deployment. The new capacity is projected to begin making a positive impact sometime in mid-2019. Price increases have been seen in the 5–15% range.



A NEW QUARTERLY MAGAZINE



*With original content dedicated specifically to flex system and PCB designers, electrical engineers and those responsible for integrating flex into their products at the OEM/CEM level, you won't want to miss a single issue of **Flex007 Magazine!***

[Subscribe](#)

[Contribute](#)

[Advertise](#)

I-Connect007
GOOD FOR THE INDUSTRY



Artificial Muscle Takes Origami to the Next Level

A team of engineers from Bristol Robotics Laboratory and Engineering Mathematics created an artificial muscle technology inspired by the ancient art of origami. Their invention uses electrostatic forces that zip structures together like a zipper on a coat. These structures can be made from any combination of insulating and conducting materials such as metal, plastic, and even pencils and office paper.

"With electro-origami, we can replace electromagnetic motors with light, scalable, silent alternatives," said Dr. Majid Taghavi, one of the inventors of the technology. "Because electrostatic devices do not require high currents, they produce much less heat and can be much more efficient than electric motors."

The research, published in *Science Robotics*, comes from the team who previously found fame with The Right Trousers project where they developed smart robotic trousers to improve the mobility of older adults and people with disabilities.

Professor Jonathan Rossiter, who co-authored the study alongside Dr. Taghavi and Dr. Tim Helps at the University's SoftLab, sees many applications for this technology. "We believe electro-origami could be used in wearable devices that give you a boost in power and keep you physically independent in space applications to produce solar panels that fold away like tree leaves inside buds and even in robotic art where tactile surfaces and structures morph like living things," he said.

The Bristol team aim to put electro-origami technology into products within a few years and have been awarded follow-on funding to pursue commercial applications. They are already building on their impressive early-stage results to deliver the next generation of stronger, lighter, and faster electro-origami devices and artificial muscles.

(Source: University of Bristol)



Imagine an electrically powered device as thin as paper, as powerful as human muscle, and capable of lifting 1,000 times its own weight.

Summary

These three categories lead the way in today's market as highly constrained and underinvested commodity components. Historically, this type of market is better fitted to the memory devices that are prevalent in many electronics. The difference in the current and previous market cycles is that the situation we see today should more fittingly be classified as a trend as opposed to a typical market cycle. I say this based on the continued content expansion required by today's electronics as compared to the slow expansion of capacity. Unfortunately, it looks like our challenges to support this trend are here to stay. **SMT007**



Jamey Mann is the director of global supply chain for Kimball Electronics.



Electronics in Harsh Environments



Submit your
2019
Abstract Today!

2-4 April 2019

**Radison Blu Hotel
Amsterdam, Netherlands**

www.smta.org/harsh

SMTA Europe is proud to host the Electronics in Harsh Environments Conference on 2-4 April 2019 in Amsterdam, Netherlands. This conference will focus on the challenges and best practices for building reliable electronic devices that will perform to design standards when used in harsh environments.

 **SMTA**
EUROPE

Call for Abstracts
Due 19 November

You are invited to share your research at the conference. Suggested topics below:

- Building reliable high density assemblies
- Ruggedization of electronics in automotive applications
- Predicting component life in harsh environments
- Impact of harsh environments on reliability
- High temperature soldering
- Monitoring and tracking production hardware
- Obsolescence and life cycle management
- Power electronics
- Failure Analysis
- Product assembly challenges
- Material selection and advancement test methods
- Adhesive and coating development

Natasha Baker: Supply Chain Transparency Inside the CAD Tool



Feature Interview by Nolan Johnson
I-CONNECT007

Natasha Baker, CEO and founder of SnapEDA, an online parts library, discusses the benefits of transparency in online libraries to designers, and discusses strategies on how to solve supply chain challenges, and more.

Nolan Johnson: Natasha, can you give us an overview of what your company does?

Natasha Baker: My company is SnapEDA. We launched in 2013 and built the internet's first parts library for circuit board design. SnapEDA is a place for engineers to access the libraries they need to build PCBs. Users can drag and drop symbols, footprints, and 3D models right from our website. There are many challenges to face when designing a circuit board in both the design and manufacturing process. Our mission is to remove the barriers and make the process more seamless when bringing a product to life.

Johnson: This is an emerging space in the entire PCB marketplace. How do you handle conversations around supply chain issues?

Baker: What we do is give engineers transparency into different areas that they've never had transparency in before, including where to find the part, how to select parts that have availability in the marketplace, how to substitute a part if it goes out of stock, and how can you find a part with particular specifications. The biggest thing we're giving engineers is ready-to-use data, transparency into the quality of that data, and a view into the supply chain. We address questions such as, "Is this component available? Who has it in stock? Would this part be wise to put into my design, or is the component obsolete and I should not use it?"

Johnson: What are some ways that transparency might help your users and what are the bottlenecks your users are talking to you about in this area?

Solving Problems Before They Occur: **Manufacturability for Smarties**

How to avoid common manufacturing pitfalls that can cause delay, create cost overruns, and impact quality.



[DOWNLOAD PDF >](#)

DID YOU KNOW WE OFFER:

Assembly

RF/Microwave

Layout

DFM

CAD Software with SnapEDA

Solder Stencils

Around the Clock

CUSTOMER SUPPORT



Baker: The most direct example is that engineers can see right away whether an item is in stock or not, and how much it costs at various distributors. If it's not in stock, we'll recommend one they can use with similar specifications and functionality, and even give them the CAD files.

Johnson: The traditional way to specify parts is by performance characteristics, but now you have supply chain availability to consider. It seems like your customers can now shop for the functionality of a part appropriate for a particular design. Are these the dynamics you're seeing from your customers?

Baker: Definitely. Since we have built up a large database of vendor specifications, we can make recommendations for similar parts. If we see that the one that the engineer wanted to use (or maybe even currently is being used in a product that's being updated) is obsolete, we'll recommend one that is in stock that has specifications. This is a win-win, because no one likes to rework their design and have to scramble to find a substitute part.

This is a win-win, because no one likes to rework their design and have to scramble to find a substitute part.

Johnson: As a broker between the designers and the manufacturers, does your community have discussions about parts availability or counterfeit parts? If so, how do you communicate availability issues to your users and are you actively doing anything to identify counterfeit parts?

Baker: Yes, it's definitely a concern for our community. Since we promote distributors to our community, it's important that, we only work with authorized distributors. Since this is

such a huge problem for engineers, we made the conscious decision to only work with trusted, authorized distributors.

In the supply chain, we find ourselves in an interesting position because we're engaging at this pivotal point where engineers are making their design decisions. Engineers look to us to make sure the components they choose are going to be right for their designs and that we'll only link them to trusted sources. We now sell components directly from their websites. Getting components directly from the manufacturers is another way that engineers can guarantee they are ordering are legitimate.

Johnson: You're involved in the conversation between the designers and the distributors who sell the parts in a way that hasn't been done before. It seems like distributors could positively respond to you or see you as a disruptor. How would you describe the relationship between you and the distributor?

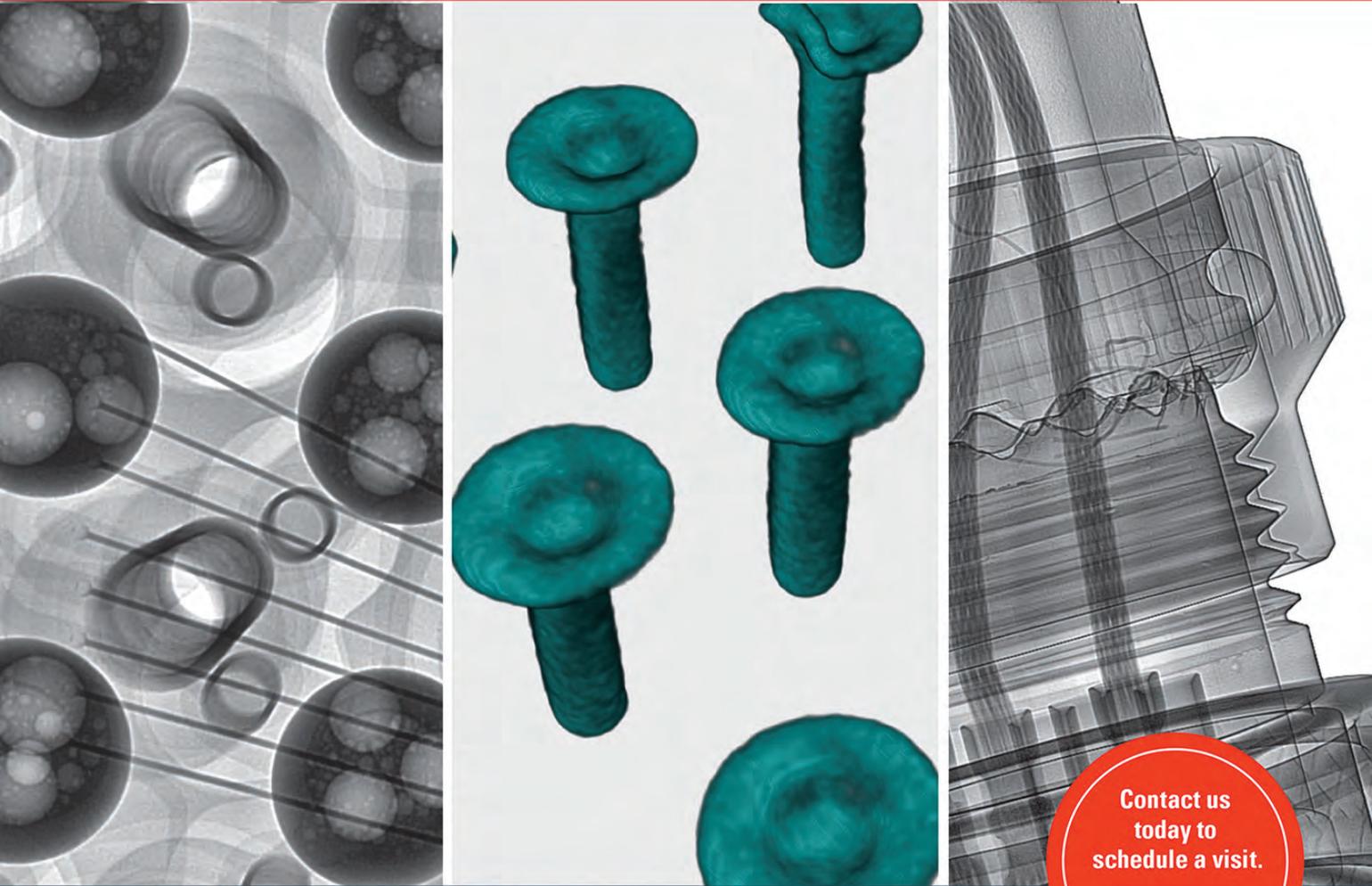
Baker: We have a very collaborative and complementary relationship with distributors. Our website is a place to discover and design-in components, but ultimately, we're referring designers to distributors to buy. If you visit one of these distributors' warehouses, it's absolutely incredible the logistics that go into what they do. It would be very hard for any company, except maybe Amazon, to disrupt these companies.

Overall, we want to help engineers discover components and design boards. We also want to connect people to the various places in the supply chain and help break down barriers without replacing anything that already exists. We're not looking to replace anyone's business. We're a new type of business model that hasn't existed before. We've invented our own niche that provides value to the vendors we work with and the distributors, which is why we're seeing traction.

Johnson: Does it seem like the majority of your users are active in accessing your database?

Baker: Yes, we have a very active user base.

When you see, you know.



Contact us
today to
schedule a visit.

Lab One

Are you ready to meet the next generation of electronics inspection systems?

Want to learn what the new YXLON X-ray and CT inspection systems can do for you?
Come see for yourself at Lab One—our new Silicon Valley facility.

With X-ray & CT, RF Power, and ebeam technology and expertise all under one roof,
Lab One is here to help you find solutions and capture opportunities. **Contact us today.**

COMETGROUP
Technology with Passion

COMET
YXLON
ebeam

📞 (408) 786-0276

🌐 comet-group.com/lab-one

✉️ LabOne@comet-group.com

Johnson: Once they join and see the value, do they keep coming back to what you have to offer?

Baker: Absolutely. A lot of people don't get what we do at first. But once they try it, they keep coming back because it's a bit of a magical experience.

Johnson: Is one body of your audience easier to integrate with than the other?

Baker: In the beginning, it was easier to work with distributors because they instantly see the value since people buy components. The vendor portion took longer, but now our value is clear to them. We're working with them more. I'm excited about this because I feel like we can help them a lot.

Johnson: Where do you see your product going in the next three to five years?

Baker: There are so many things I want to do and that I'm so excited about, but I think I'm going to keep them up my sleeve for now.

Johnson: One thing we can take away from this conversation is that you have a pretty extensive roadmap for the next three to five years.

Baker: Yes. I feel like we haven't even scratched the surface of where I want to go. Businesses can be hard because you always want to do so many things, but you can only do a portion of them. It's a constant frustration.

Johnson: That makes sense, but it seems like you have a good strategy that's disciplined and will keep you focused. Before we finish, is there anything else you'd like to discuss?

Baker: We're working something really special for electronics engineers and PCB designers over here at SnapEDA, which is so much more than just a symbol and footprint library. Yes, we're a company, but this is just as much a passion project for our team members, built out of our own experiences designing PCBs. We've made an incredible free product that saves engineers so much time, and we're constantly improving it based on the feedback we get from our community. I'd definitely recommend that readers create a free account and give it a try!

Johnson: Sounds awesome. Thank you for your time, Natasha.

Baker: Thank you so much for the opportunity to be involved in this. **SMT007**

How to Avoid Supply Chain Disruption this Chinese New Year

Chinese New Year (CNY or the Spring Festival) is China's most revered and highly anticipated annual holiday and is observed by an estimated 1.4 billion people worldwide (or close to a quarter of the world's population). The date of the festival varies from year to year depending on the lunar calendar with the 2019 celebrations marking the Year of the Pig scheduled to begin on February 5.

As China eagerly anticipates a fortnight of festivities, electronics manufacturers who source their PCBs from China will be bracing themselves for some significant logistical challenges. The reason? Chinese factory workers often work in coastal areas far from their home provinces, so CNY offers a rare opportunity for some precious family time.

While the official holiday only lasts for around 10 days (five working days, plus the weekends either side), suppliers typically wind down their operations one to two weeks in advance of the holidays to allow plenty of time for workers to travel the often vast distances back to their inland villages. And most factories aren't back running at full capacity until at least a week after the holidays officially end.

It's also not uncommon for factories to resume production with as little as a third of their original workforce; some workers simply never return at all. Uncertainty about staff levels after the holidays is a very real obstacle for Chinese factories if they're forced to replace or retrain workers after CNY, and can lead to potential quality issues for manufacturers.

(Source: Neil Sharp, JJS Manufacturing)

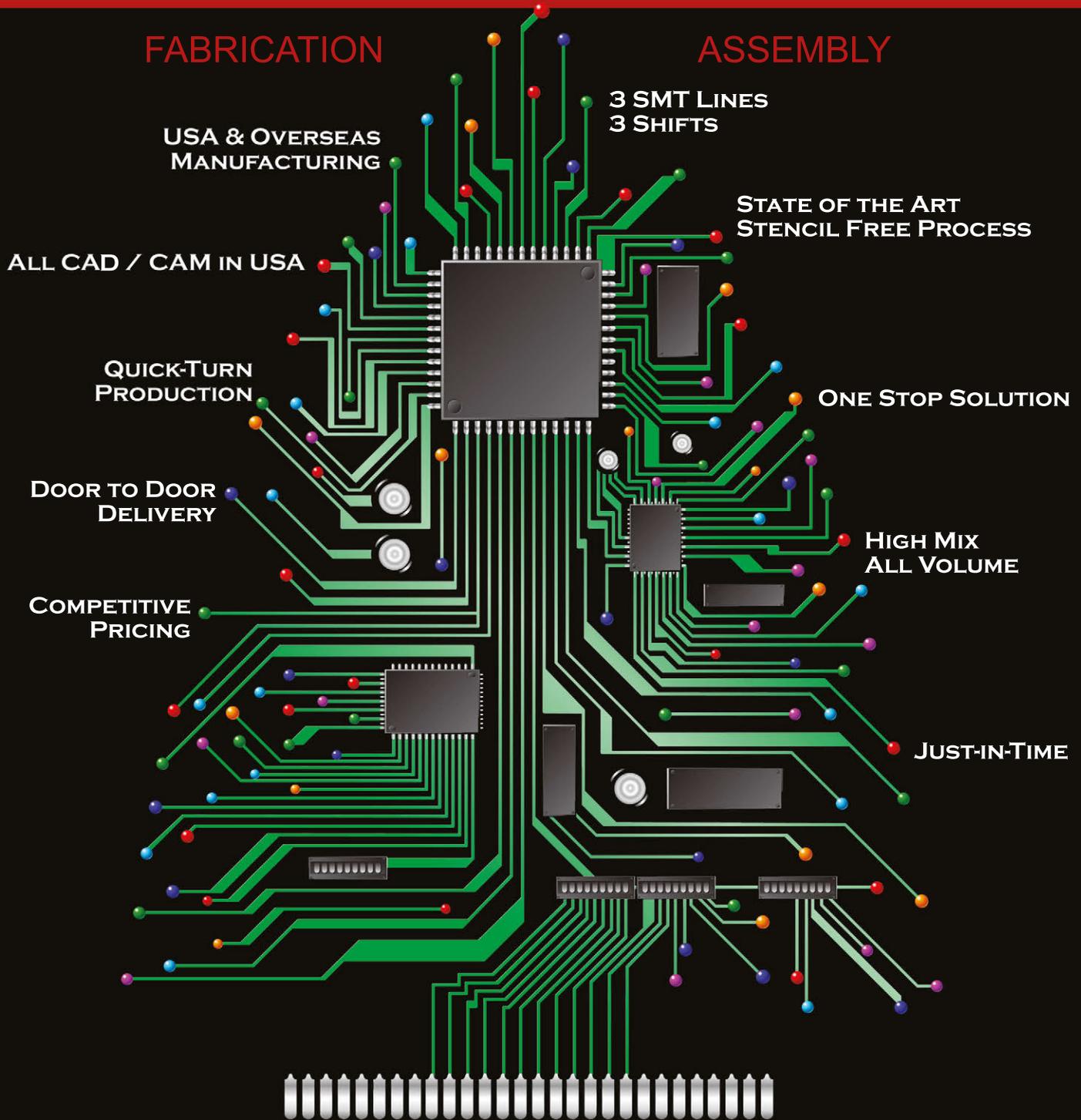
PCB FABRICATION & ASSEMBLY

CLASS 3 RIGID-FLEX METAL CORE

AS9100D ISO 9001:2015 ITAR SAM REGISTERED UL E333047

FABRICATION

ASSEMBLY



For Quality, Reliability, On-Time Delivery
& Competitive Price visit our website

WWW.PCBNET.COM



imagineering,inc. Woman Business Enterprise (WBE)
Woman-Owned Small Business(WOSB)



MilAero007 Highlights



Standard of Excellence: Preparing Your Vendors for the Future ▶

Now, it's time to talk about the future with your PCB vendors. Referring to our previous columns, if you've done everything right so far, you will now have a strong working relationship with your PCB supplier. They understand all they need to know to fabricate perfect boards for you at this time. With trust and respect between you, you've truly formed a strong partnership going into the future.

Ventec's Marketing Strategy and Their Newly Appointed Technology Ambassador ▶

At electronica 2018, Mark Goodwin, chief operating officer at Ventec International Group, discusses the company's marketing strategy along with their newly appointed technology ambassador, Alun Morgan, and how he sees the world.

Artificial Intelligence Meets Materials Science ▶

A Texas A&M University College of Engineering research team is harnessing the power of machine learning, data science and the domain knowledge of experts to autonomously discover new materials.

NATO Members Drive Fastest Increase in Global Defense Spending for a Decade ▶

Global defense expenditure grew 4.9% in 2018, the fastest growth rate since 2008, according to the annual Jane's Defense Budget report, released today by business information provider IHS Markit.

Defense Speak Interpreted: PERM—Pb-free Electronics Risk Management ▶

In this column, we explore PERM—the Pb-free Electronics Risk Management Consortium. No,

the group members do not all have curly hair! The name was chosen around 2008 by a group of engineers from aerospace, defense, and harsh environment (ADHE) organizations.

Sales of Military Antennas to Reach \$1 Billion in 2018 ▶

The report forecasts a steady decadal growth rate of 4.9% for the military antennas market, with revenue slated to reach \$986.8 million by the end of 2018.

Drones Can Now Flap Wings, Ride Wind Currents Like Birds ▶

The next generation of unmanned drones will act more like birds than machines, thanks to new research.

First Lockheed Martin-built Next-generation GPS III Satellite Responding to Commands ▶

A major milestone in the U.S. Air Force's plan to bring new technology and capabilities to the GPS constellation, the first Lockheed Martin-built GPS III satellite began "talking" with engineers and operators from ground control, as planned, following its successful launch this morning.

Marsquake Sensor Lands Safely on Red Planet ▶

A Marsquake detector designed in part by Imperial engineers is set to help reveal Mars' inner structure.

NASA Looks to the Future, Seeks Next Level Visionary Aerospace Concepts ▶

NASA is looking for trailblazing ideas that could one day change what's possible in space. The NASA Innovative Advanced Concepts (NIAC) program is seeking Phase II proposals for the continuation of Phase I research studies.

Highly Certified Premier
Mil-Aero C5ISR
Electronics Contract Manufacturing
& Engineering Design Services

DESIGN
BUILD
TEST
TRUSTED



Protect your data and choose an electronics contract manufacturer that is NIST 800-171 compliant.



Zentech was one of the first electronics manufacturers to become NIST 800-171, DFARS 252.204-7012 and FAR 52.204-21 compliant.



Zentech is considered a subject matter expert in NIST 800-171 compliance. [NIST/Matt Turpin interview](#)



NIST Compliance is just one of the many ways we take great care of our customers. [Learn more at zentech.com](#)



ZENTECH

Baltimore, MD Fredericksburg, VA

www.zentech.com • 443-348-4500 • sales@zentech.com

The Effect of Thermal Profiles on Cleanliness and Electrical Performance

Quest for Reliability

Feature Column by Eric Camden, FORESITE INC.

This month, my column will cover “The Effect of Thermal Profiles on Cleanliness and Electrical Performance.” This paper was originally published in the SMTA International proceedings of 2014 (and is reprinted here with permission), but the topic is timely and worth continuing the conversation here.

Introduction

The process of thermal profiling for reflow soldering is one of the most important considerations when setting assembly parameters. Knowing how to effectively profile includes choosing the proper equipment, understanding the results and being able to adjust as necessary. Consideration for some larger multilayer assemblies and assemblies with large thermal mass components should be made to ensure that all areas of the assembly reach the minimum recommended temperature for proper solder joint formation as well as rendering no-clean flux residues benign. A review of the assembly drawing is necessary to determine if there are heavy copper layers in select areas. The heavier layers of copper will absorb heat away from the surface of the assembly. This can lead to cold and brittle solder joint defects.

Characteristics of Profile

There are four different phases or zones to analyze under the reflow curve (Figure 1). The first is the preheating slope (temperature ramp rate), then preheat dwell (soak time), followed by time above liquidus that will include the peak

temperature, and lastly, the cooling zone.

For the paste flux used in this trial, the preheat slope should be controlled to $< 2.0^{\circ}\text{C}$ per second, which allows for gradual evaporation of the flux and will yield a higher quality solder joint without increasing the risk of associated solder defects such as solder balls, bridging, etc.

The preheat dwell phase is where the flux activators remove oxides and prepare the metal surfaces for joining with the solder paste. This phase brings the entire assembly with components to a common temperature below the melting point of the solder. This temperature is typically maintained for 60–90 seconds for most paste types.

The reflow phase is when the intermetallic formation is made. The temperature is commonly anywhere between 20–40°C above the melting point of the solder. Time above liquidus can vary between 30–90 seconds depending on thermal mass and other material choices (Figure 1).

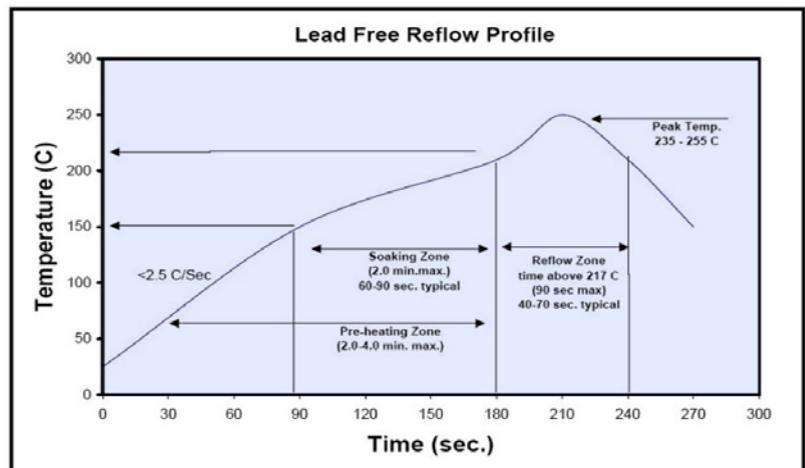


Figure 1: Example lead-free reflow profile phases.

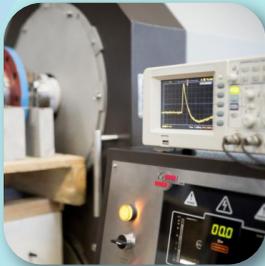


Candor

Circuit Boards

Innovative solutions for complex circuit board manufacturing

Click to see what we bring to each sector of the industry:



RF/Microwave
PCBs



Power
Electronics



High-Speed
Data



Automotive
Electronics



Lamination



Startups

Our technology produces what our customers dream!

www.candorind.com | (416) 736-6306

The cooling zone helps determine the integrity of the solder joint grain structure. A quicker cool down ramp, in comparison to the preheat phase ramp, is normally desired but take care not to exceed the CTE of components and board surface. A common recommendation for cooling ramp rate is no more than 4°C per second.

More detailed information can be found in the IPC-7530: Guideline for Temperature Profiling for Mass Soldering (Reflow and Wave) Processes.

Profiling Equipment

There are several choices of reflow profiling equipment available depending on the need. There are profilers for either the product or the reflow oven. For this study, I will focus on only the product profiling equipment that travels with the product, thus eliminating the need for long wires that run the length of the oven. The product profiler should be capable of measuring multiple locations on the assembly. Most commercially available traveling type profilers have up to six separate thermocouples. Some have real-time measurements sent to a receiver on a computer display, and others use internal memory to store the data points for downloading after the product exits the reflow oven. Either type can yield the desired analysis.

Design of Experiment

Multiple thermal profiles were used for this experiment to determine what effect temperature has on cleanliness and electrical resistance measurements. Cleanliness was measured using ion chromatography (IC) and surface insulation resistance (SIR) testing is performed in an environment of 40°C and 90% relative humidity with 5V bias with measurements made every 10 minutes. All test boards are the Umpire two qualification test board (Figure 2).

The first thermal profile was 20° below the recommended limit. The second profile group was done at 10° below the recommended limit. Meanwhile, the third profile group was done at the manufacturer's recommended profile for the solder paste. This is what is considered the minimum allowable temperature for proper

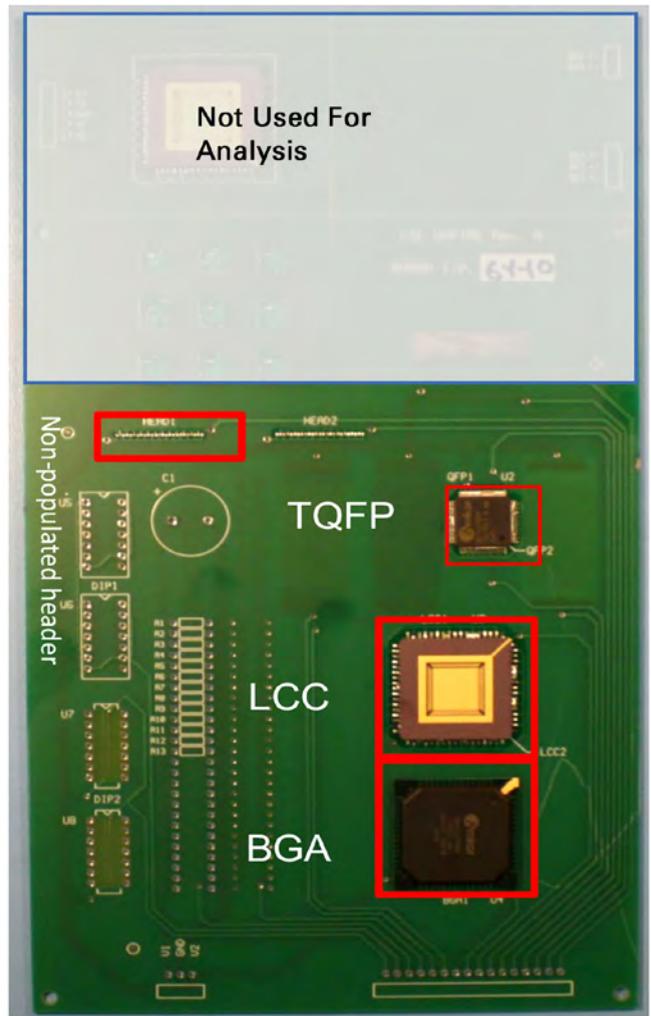


Figure 2: Umpire two test board.

solder joint formation and full flux activation. The fourth profile was done at 10° above the recommended limit.

Ten boards were processed for each profile group, and of the 10, five were tested with IC; the remaining five from each group were subjected to SIR testing. Each board was measured at four different locations including an LCC, TQFP, BGA, and a non-populated row of headers for reference.

Analysis Techniques

As previously mentioned, the experiments involved two kinds of analysis techniques: IC and SIR testing.

All IC testing was performed using a Dionex ICS 3000 chromatography system with Chromeleon software. The extractions were performed using an automated localized extraction



Figure 3: Group 1 thermal profile.

technique. The parts were all mechanically removed, and the samples were taken from the board level. Localized extractions are of utmost importance as they do not normalize out pockets of contamination across the full surface area of the assembly like other extraction and test methods do. A raw sample of the chosen solder paste was tested with IC to determine the main constituents of the paste activator. All samples were compared to the raw paste IC data when determining the level of ionic cleanliness.

The SIR testing was performed in a standard environmental chamber capable of maintaining a temperature within $\pm 1^\circ\text{C}$ and relative

humidity within 3%. A calibrated automatic switching measurement system was used for the electrical measurements taken once every 10 minutes.

Thermal Profile Group 1

The first thermal profile group was processed at a worst-case temperature of 20° below what is recommended by the solder paste manufacturer. This is a profile that barely achieves liquidus state of the paste and could be a function of multiple failing heating sources, an improper recipe being used (possible a standard leaded profile), or other unknowns (Figure 3).

all values in $\mu\text{g}/\text{in}^2$		Ion Chromatography (Dionex ICS 3000 at Foresite) n/a = not applicable															
Foresite recommended limits for PCBA (no clean)		F ⁻	C ₂ H ₃ O ₂ ⁻	Cl ₂ O ₂ ⁻	Cl ⁻	NO ₂ ⁻	Br ⁻	NO ₃ ⁻	PO ₄ ³⁻	SO ₄ ²⁻	WOA	MSA	Li ⁺	Na ⁺	NH ₄ ⁺	K ⁺	Ce ²⁺
Group #	Board #	1	3	3	3.00	3	6.0	3	3	3.0	150	1	3	3	3	3	n/a
Raw Solder Paste		0.61	273.44	39.06	61.02	0.81	0.24	0.86	0	4.77	4.48	0	248.49	10.26	23.57	64.65	15.47
G1-B1	TQFP	0.58	12.54	2.61	3.47	0.14	0.30	0.75	0	2.74	2.55	0	30.40	6.18	1.06	1.84	8.66
G1-B1	LCC	0.76	13.99	5.21	4.35	0.98	0.22	0.15	0	2.56	0.85	0	28.98	6.12	1.33	0.50	9.39
G1-B1	BGA	0.28	10.84	3.17	16.30	0.12	0.13	0.44	0	3.06	0.63	0	31.32	3.77	0.88	0.84	9.71
G1-B1	Header	0.11	9.54	2.52	1.74	0.96	0.18	0.51	0	3.31	0.52	0	30.22	7.86	1.34	1.36	5.98
G1-B2	TQFP	0.88	14.57	2.95	3.24	0.36	0.31	0.40	0	3.68	0.73	0	32.77	7.26	1.91	1.29	7.35
G1-B2	LCC	1.00	12.07	3.62	1.80	0.57	0.35	0.16	0	3.82	3.74	0	35.23	3.65	1.79	0.71	3.53
G1-B2	BGA	1.05	11.55	3.59	1.56	0.47	0.24	0.18	0	3.98	0.30	0	33.83	4.31	1.36	1.01	10.43
G1-B2	Header	0.05	6.79	3.18	1.37	0.84	0.41	0.16	0	2.67	n.a.	0	41.15	7.28	0.97	0.66	3.15
G1-B3	TQFP	0.82	13.39	2.22	3.10	0.34	0.32	0.12	0	3.53	0.71	0	34.37	6.91	1.25	1.03	5.49
G1-B3	LCC	1.02	16.52	3.89	4.28	0.32	0.70	0.21	0	3.77	1.95	0	34.85	4.64	3.30	1.07	10.22
G1-B3	BGA	0.70	12.62	3.23	4.62	0.79	0.41	0.49	0	4.41	0.57	0	33.91	3.02	1.03	1.18	12.47
G1-B3	Header	0.23	6.75	2.60	3.93	1.07	0.33	0.10	0	3.12	1.02	0	41.38	5.94	0.81	0.14	0.71
G1-B4	TQFP	0.90	11.43	3.01	2.82	0.28	0.37	0.29	0	4.10	2.15	0	27.71	3.90	1.54	1.54	11.06
G1-B4	LCC	0.71	13.51	5.82	1.55	0.47	0.52	0.23	0	3.54	2.70	0	27.48	5.11	1.43	0.49	9.84
G1-B4	BGA	0.84	10.05	3.05	14.83	0.51	0.78	0.37	0	3.96	0.46	0	34.64	3.23	0.79	1.09	12.59
G1-B4	Header	0.02	10.55	2.82	5.87	0.66	0.68	0.15	0	2.96	2.40	0	30.38	6.33	1.05	1.51	7.06
G1-B5	TQFP	0.23	11.98	2.98	1.63	0.93	0.30	0.16	0	4.21	2.08	0	32.24	5.80	1.38	1.26	5.93
G1-B5	LCC	0.13	14.94	3.34	1.94	0.67	0.21	0.09	0	3.06	1.66	0	34.12	3.41	1.61	0.91	5.80
G1-B5	BGA	0.14	15.86	4.30	2.13	0.17	0.35	0.09	0	4.30	2.74	0	40.22	4.20	1.30	1.55	13.68
G1-B5	Header	0.02	12.68	1.94	1.47	0.56	0.13	0.13	0	2.27	1.05	0	53.61	4.71	1.64	0.31	0.78

Table 1: IC data for Group 1.

Group 1 IC Results

The raw paste IC sample shows that acetate, chloride, lithium, sodium, ammonium, and potassium are the ions of highest concentration, and also of highest concern after each reflow profile variation. This worst-case profile shows highly elevated levels of acetate, chloride, lithium, and sodium. The ammonium and potassium levels depreciate greatly with this profile (Table 1).

Group 1 SIR Results

Group 1 SIR results show that all samples fail the IPC limits of 1.0e8 ohms of resistance (Figure 4).

Thermal Profile Group 2

Group 2 is a much more realistic profile than Group 1 that shows the effect of the flux residues left behind on the analysis when the temperatures are only 10° below the recommended limits. However, 10° variability is not out of the question for larger thermal mass boards and components and emphasizes the importance of profiling the assembly as well as the equipment. The equipment must also be tested to ensure that all heating elements are functioning properly. See Figure 5 for the thermal profile, Table 2 for IC data, and Figure 6 for SIR data.

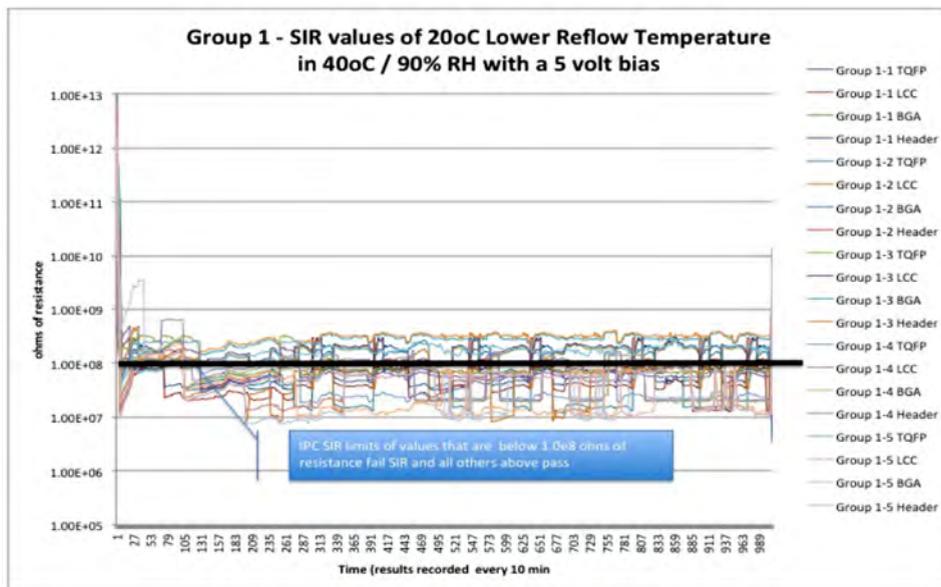


Figure 4: SIR results for Group 1.

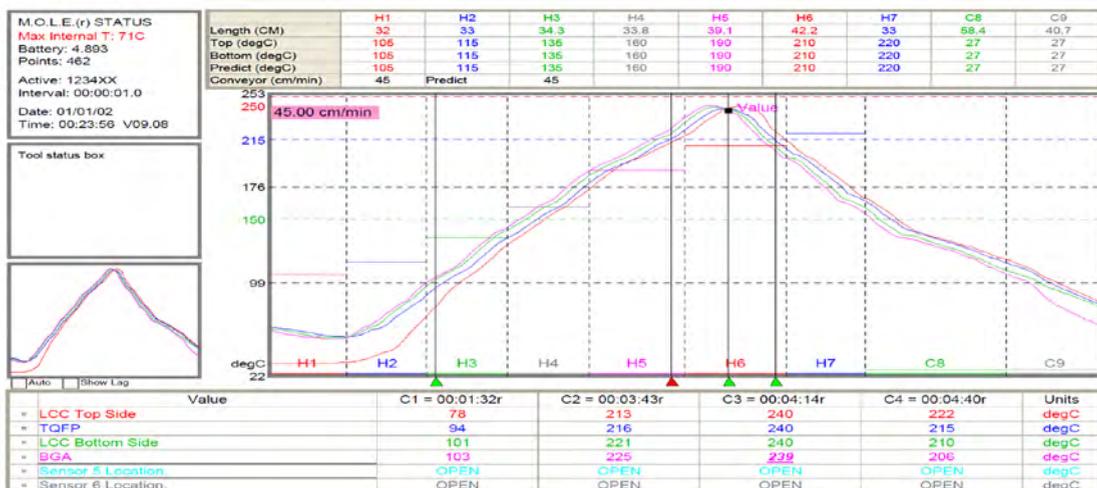


Figure 5: Group 2 thermal profile.

all values in $\mu\text{g}/\text{in}^2$		Ion Chromatography (Dionex ICS 3000 at Foresite) n/a = not applicable															
		F ⁻	C ₂ H ₃ O ₂ ⁻	Cl ₂ O ₂ ⁻	Cl ⁻	NO ₂ ⁻	Br ⁻	NO ₃ ⁻	PO ₄ ³⁻	SO ₄ ²⁻	WOA	MSA	Li ⁺	Na ⁺	NH ₄ ⁺	K ⁺	Ca ²⁺
Foresite recommended limits for PCBA (no clean)		1	3	3	3.00	3	6.0	3	3	3.0	150	1	3	3	3	3	n/a
Group #	Board #																
Raw Solder Paste		0.61	273.44	39.06	61.02	0.81	0.24	0.86	0	4.77	4.48	0	248.49	10.26	23.57	64.65	15.47
G2-B1	TQFP	0.07	7.79	3.12	1.10	0.13	0.25	0.36	0	0.56	1.14	0	14.87	2.44	7.91	1.84	8.66
G2-B1	LCC	0.34	5.20	4.19	1.51	0.09	0.03	0.65	0	0.84	2.40	0	10.70	9.87	12.55	0.50	9.39
G2-B1	BGA	0.65	7.61	2.58	1.16	0.12	0.20	0.47	0	1.21	1.34	0	10.13	5.67	4.50	0.84	9.71
G2-B1	Header	0.97	1.18	1.16	0.62	n.a.	0.11	0.20	0	0.38	1.01	0	2.86	0.63	1.88	1.36	2.98
G2-B2	TQFP	0.96	8.57	3.64	2.03	0.18	0.04	0.85	0	0.51	2.63	0	12.18	2.89	5.83	1.29	7.35
G2-B2	LCC	0.63	11.75	3.59	2.37	0.09	0.30	0.33	0	0.27	1.31	0	11.01	7.44	8.53	0.71	3.53
G2-B2	BGA	0.66	12.71	3.13	0.87	0.10	0.10	0.05	0	0.69	2.55	0	11.06	5.34	8.81	1.01	10.43
G2-B2	Header	0.56	0.66	1.24	0.92	0.14	0.05	0.02	0	0.12	1.50	0	2.12	1.31	2.32	0.66	1.15
G2-B3	TQFP	0.82	10.08	2.89	1.38	0.08	0.13	0.13	0	0.94	2.38	0	10.86	1.07	3.76	1.03	5.49
G2-B3	LCC	0.59	9.86	3.11	2.56	0.22	0.13	0.89	0	1.11	1.39	0	10.96	8.71	10.11	1.07	10.22
G2-B3	BGA	0.50	7.88	2.41	1.27	0.21	0.08	0.36	0	1.05	1.95	0	11.40	5.55	4.70	1.18	12.47
G2-B3	Header	0.41	1.13	1.45	1.19	0.23	0.14	0.13	0	0.54	1.04	0	1.61	0.83	2.58	0.14	0.71
G2-B4	TQFP	0.19	10.67	1.13	1.40	0.24	0.60	0.35	0	0.62	1.86	0	12.58	1.83	5.98	1.54	11.06
G2-B4	LCC	0.10	12.53	2.99	2.08	0.11	0.21	0.14	0	0.42	1.24	0	11.85	2.87	4.21	1.32	6.32
G2-B4	BGA	0.31	11.83	3.84	3.26	0.26	0.07	0.24	0	0.33	1.59	0	12.96	3.15	4.65	2.01	5.54
G2-B4	Header	0.39	1.02	0.95	0.91	0.19	0.06	0.10	0	0.19	0.98	0	2.01	1.29	2.77	0.54	2.01
G2-B5	TQFP	0.22	8.44	2.16	4.01	0.14	0.11	0.18	0	0.27	2.20	0	13.10	2.98	3.96	1.22	3.67
G2-B5	LCC	0.44	9.61	3.02	3.25	0.22	0.27	0.07	0	0.28	3.01	0	12.43	3.01	4.02	1.63	4.21
G2-B5	BGA	0.38	9.74	4.01	3.64	0.34	0.30	0.11	0	0.30	2.57	0	12.22	2.57	3.65	1.25	3.96
G2-B5	Header	0.27	0.98	1.29	1.01	0.09	0.14	0.12	0	0.16	1.13	0	1.45	1.03	1.43	0.91	2.14

Table 2: IC data for Group 2.

Group 2 IC Results

The IC results for Group 2 shows lower levels of most ionics, but most are still above the recommended limits. In particular, the acetate, lithium, and sodium ions are still at a level that will increase the risk of failure in a normal field service environment.

Group 2 SIR Results

All locations with components failed both the SIR criteria as well as the recommended IC limits. The header (non-populated) area did pass both SIR and IC testing due to the lack of thermal mass.

Thermal Profile Group 3

The manufacturer recommends a maximum ramp of $< 2^\circ$ per second with a dwell time of between 30–90 seconds at peak temperature. For this study, a peak temp of 250° and a dwell time of ~ 60 seconds was chosen. The profile is seen in Figure 7, IC results in Table 3, and SIR results in Figure 8.

Group 3 IC Results

The manufacturer recommended profile renders all of the flux activators benign in the areas tested with and without components. Looking at the profile for Group 3, all of the

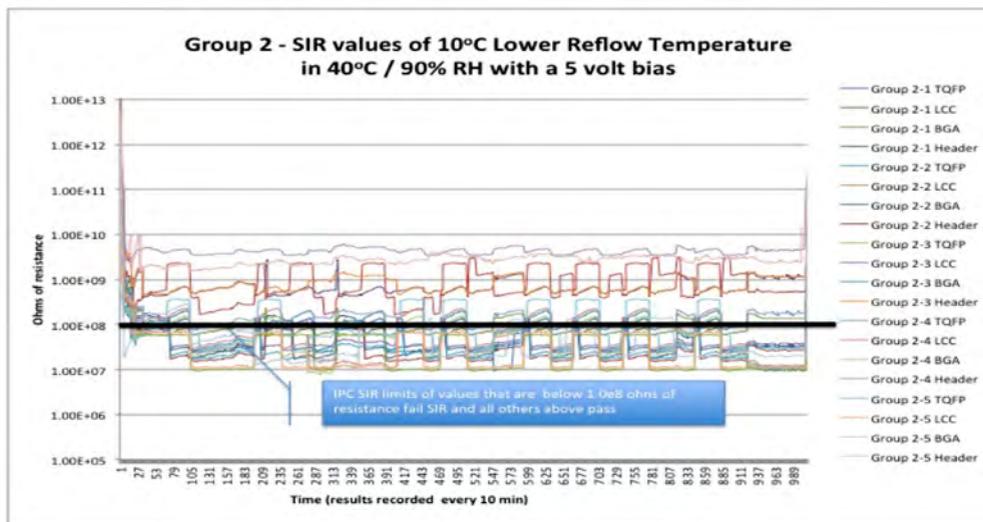


Figure 6: SIR results for Group 2.



Figure 7: Group 3 thermal profile.

all values in $\mu\text{g}/\text{m}^2$		Ion Chromatography (Dionex ICS 3000 at Foresite) n/a = not applicable																
Foresite recommended limits for PCBA (no clean)		F	C ₂ H ₃ O ₂	CH ₃ O ₂	Cl ⁻	NO ₂ ⁻	Br ⁻	NO ₃ ⁻	PO ₄ ³⁻	SO ₄ ²⁻	WOA	MSA	Li ⁺	Na ⁺	NH ₄ ⁺	K ⁺	Ca ²⁺	
Group #	Board #																	
Raw Solder Paste		0.61	273.44	39.06	61.02	0.81	0.24	0.86	0	4.77	4.48	0	248.49	10.26	23.57	64.65	15.47	
G3-B1	TQFP	0	2.58	2.45	1.97	0.37	1.33	0.08	0	2.59	0.39	0	1.91	1.60	1.41	0.91	1.53	
G3-B1	LCC	0	1.88	2.16	1.41	0.32	1.53	0.05	0	1.46	0.40	0	2.84	1.55	2.89	2.03	3.29	
G3-B1	BGA	0	2.46	2.24	1.41	0.42	1.06	0.04	0	1.22	2.78	0	2.06	1.38	1.34	1.53	2.38	
G3-B1	Header	0	0.13	1.15	0.44	0.56	0.43	0.02	0	1.61	1.88	0	1.16	1.13	1.10	0.86	2.56	
G3-B2	TQFP	0	1.31	2.28	2.00	0.43	1.30	0.28	0	2.28	2.02	0	2.24	0.79	1.89	2.33	2.30	
G3-B2	LCC	0	1.33	1.98	0.93	0.31	1.28	0.03	0	2.23	1.47	0	2.99	0.81	0.96	2.80	2.29	
G3-B2	BGA	0	1.63	1.94	1.04	0.66	0.88	0.01	0	2.68	1.24	0	1.16	0.92	0.96	1.74	3.02	
G3-B2	Header	0	0.24	0.39	0.54	0.04	0.71	0.05	0	1.10	2.24	0	0.77	0.45	0.79	0.70	2.03	
G3-B3	TQFP	0	2.08	2.38	1.39	0.41	1.23	0.15	0	2.24	2.25	0	1.69	1.76	1.15	0.24	0.67	
G3-B3	LCC	0	1.41	2.73	1.07	0.53	1.49	0.04	0	2.56	2.08	0	1.88	1.71	1.09	1.99	2.43	
G3-B3	BGA	0	1.88	2.02	1.25	0.19	1.54	0.09	0	2.53	1.91	0	2.05	1.57	0.90	2.23	1.47	
G3-B3	Header	0	0.80	0.74	0.87	0.49	0.90	0.30	0	1.41	0.29	0	0.79	1.22	1.23	1.05	2.28	
G3-B4	TQFP	0	1.34	3.06	1.28	0.28	1.27	0.16	0	2.91	1.59	0	1.19	2.32	0.98	1.96	3.29	
G3-B4	LCC	0	0.98	2.43	1.06	0.23	1.84	0.05	0	2.64	3.06	0	2.01	2.08	0.90	2.40	2.58	
G3-B4	BGA	0	1.67	2.55	0.36	0.27	1.18	0.14	0	1.58	2.43	0	2.39	1.68	0.95	2.35	1.96	
G3-B4	Header	0	0.87	1.05	0.93	0.17	1.29	0.16	0	1.08	1.99	0	0.56	0.66	1.12	1.01	1.44	
G3-B5	TQFP	0	1.34	3.06	0.75	0.26	1.42	0.11	0	2.66	2.72	0	1.31	2.63	0.76	1.16	3.83	
G3-B5	LCC	0	1.52	2.30	1.53	0.48	2.78	0.17	0	1.57	2.37	0	2.92	3.04	1.06	1.71	1.64	
G3-B5	BGA	0	1.74	1.31	1.25	0.29	1.34	0.11	0	2.42	3.38	0	1.31	1.51	1.26	1.93	1.31	
G3-B5	Header	0	1.01	0.93	1.21	0.12	1.12	0.19	0	0.98	1.22	0	0.41	0.69	0.98	1.22	0.60	

Table 3: IC results for Group 3.

areas reached at least 246°C which is within the recommended range of 25–45° above the melting point of the solder.

Group 3 SIR Results

All locations with and without components passed the acceptance criteria. The data in Figure 8 shows that at no time did the resistance measurement dip below the 1.0e8 ohms of resistance. This indicates that in a normal field service environment without excessive available atmospheric moisture, the product should not fail when voltage is applied.

Thermal Profile Group 4

The final group was processed at a peak temperature of 260°C to determine what, if any, effect additional thermal energy has in relation to cleanliness and SIR performance. The preheat and cooling ramp are still within the recommended limits (Figure 9).

Group 4 IC Results

The additional thermal energy did not significantly reduce the level of ionics beyond the peak temperature of 250°C. Adding thermal energy can actually be detrimental and induce damage

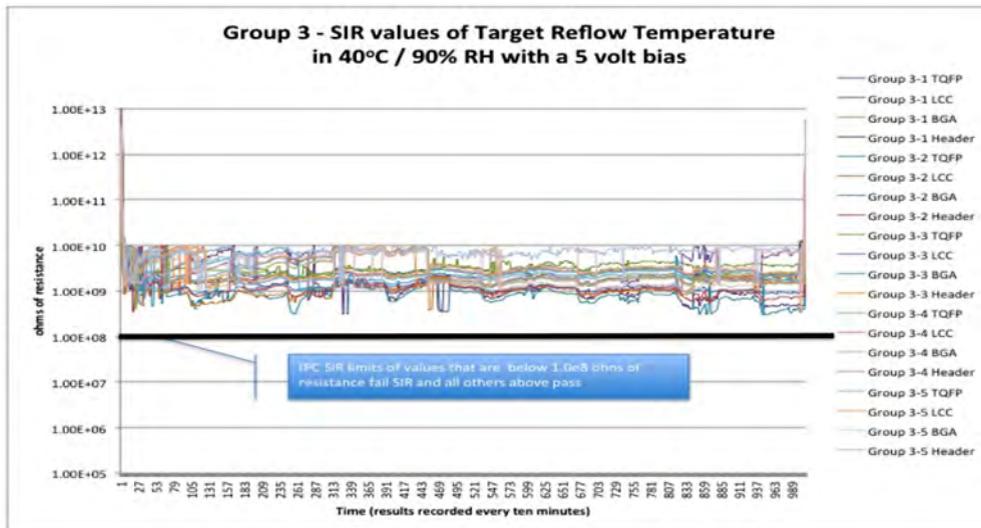


Figure 8: SIR results for Group 3.

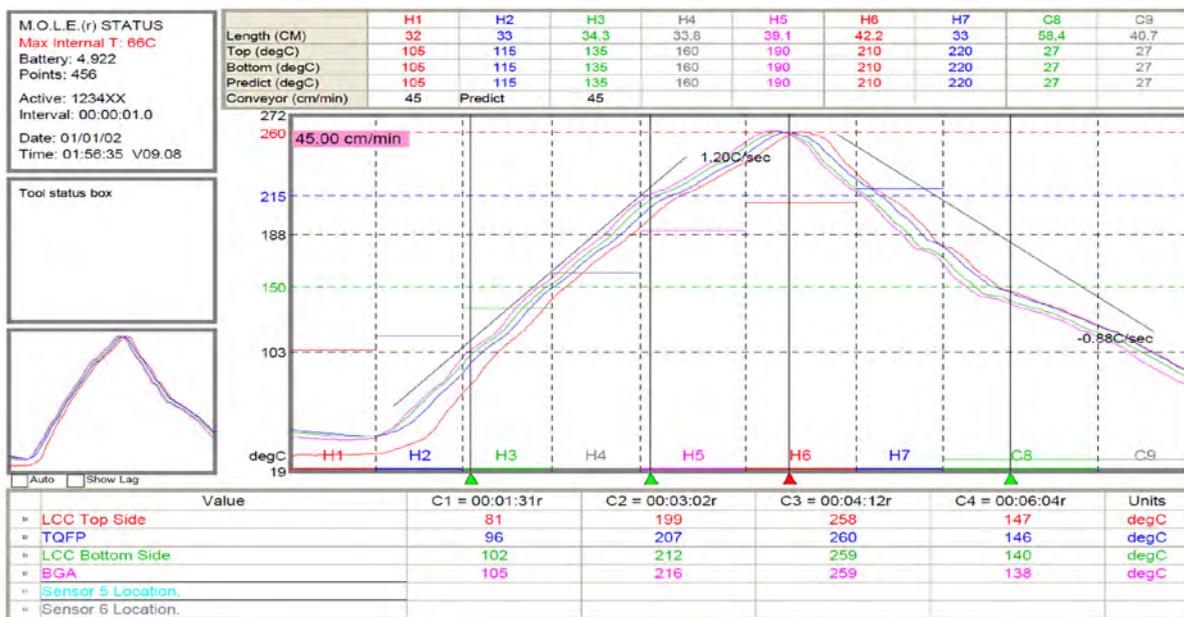


Figure 9: Group 4 thermal profile.

in certain types of components. The data in Table 4 shows similar levels to that of Group 3.

Group 4 SIR Results

All locations with and without components passed the acceptance criteria, much as with Group 3. The data in Figure 10 shows that at no time did the resistance measurement dip below the 1.0e8 ohms of resistance. This indicates that in a normal field service environment without excessive available atmospheric moisture, the product should not fail when voltage is applied.

Conclusions

The final reliability of an assembly relies heavily on the thermal profile used for soldering. When the peak temperature is too low, excess amounts of active flux residues are left behind. Further, when ample moisture is available from a normal operating atmosphere or from condensing moisture anomalies, there is a greatly increased risk of failure due to electrical leakage and/or electrochemical migration. Active no-clean flux residues are conductive in general, and when moisture is absorbed into the residue across non-common conduc-

all values in $\mu\text{g}/\text{in}^2$		Ion Chromatography (Dionex ICS 3000 at Foresite) n/a = not applicable															
Foresite recommended limits for PCBAs (no clean)		F ⁻	C ₂ H ₃ O ₂ ⁻	CH ₃ O ₂ ⁻	Cl ⁻	NO ₂ ⁻	Br ⁻	NO ₃ ⁻	PO ₄ ³⁻	SO ₄ ²⁻	WOA	MSA	Li ⁺	Na ⁺	NH ₄ ⁺	K ⁺	Ca ²⁺
Group #	Board #	1	3	3	3.00	3	6.0	3	3	3.0	150	1	3	3	3	3	n/a
Raw Solder Paste		0.61	273.44	39.06	61.02	0.81	0.24	0.86	0	4.77	4.48	0	248.49	10.26	23.57	64.65	15.47
G4-B1	TQFP	0	1.27	2.02	1.84	0.18	0.13	0.10	0	1.87	0.41	0	1.18	0.96	1.52	1.24	2.03
G4-B1	LCC	0	1.25	1.54	0.96	0.52	0.33	0.07	0	2.01	0.33	0	1.54	1.21	2.01	1.49	1.11
G4-B1	BGA	0	2.21	2.87	1.21	0.33	0.15	0.11	0	1.02	1.24	0	1.54	1.32	0.94	0.96	1.98
G4-B1	Header	0	0.22	1.06	0.58	0.35	0.42	0.06	0	0.88	0.74	0	0.93	0.98	0.95	1.41	1.85
G4-B2	TQFP	0	2.01	2.61	1.63	0.14	0.31	0.19	0	1.29	2.06	0	1.05	1.02	1.12	1.62	2.64
G4-B2	LCC	0	1.27	1.22	0.81	0.19	0.26	0.17	0	1.14	1.27	0	1.34	1.13	0.88	1.10	1.18
G4-B2	BGA	0	1.24	0.89	2.11	0.54	0.74	0.11	0	2.51	0.94	0	0.79	0.89	0.87	1.83	2.31
G4-B2	Header	0	0.36	0.21	0.74	0.29	0.59	0.04	0	0.94	2.01	0	1.18	0.32	0.17	0.62	0.57
G4-B3	TQFP	0	1.54	2.41	1.22	0.78	0.35	0.27	0	1.09	2.31	0	0.83	0.88	1.54	0.49	0.89
G4-B3	LCC	0	2.17	1.76	2.09	0.07	0.51	0.33	0	1.99	1.97	0	1.15	0.95	1.33	1.17	1.87
G4-B3	BGA	0	1.47	1.15	2.27	0.36	1.01	0.02	0	2.02	1.86	0	1.09	1.17	1.02	0.98	1.54
G4-B3	Header	0	0.44	0.88	0.48	0.51	0.08	0.21	0	0.84	0.31	0	0.53	0.44	0.57	0.16	1.02
G4-B4	TQFP	0	1.05	2.86	1.92	0.14	0.87	0.18	0	1.19	1.02	0	0.87	1.18	0.68	1.82	2.31
G4-B4	LCC	0	1.46	1.83	0.88	0.37	0.93	0.16	0	1.64	2.41	0	1.24	1.54	0.89	1.87	1.82
G4-B4	BGA	0	1.75	2.12	0.67	0.55	0.57	0.13	0	1.47	1.03	0	2.01	1.22	1.21	1.52	1.47
G4-B4	Header	0	0.91	0.94	0.37	0.06	0.93	0.08	0	1.65	0.54	0	0.47	0.33	0.41	0.85	0.97
G4-B5	TQFP	0	1.86	2.71	1.17	0.44	0.25	0.26	0	2.22	1.86	0	1.24	1.15	1.28	0.62	1.41
G4-B5	LCC	0	1.88	2.18	1.77	0.37	0.64	0.14	0	1.67	2.03	0	1.14	2.12	0.57	0.81	0.93
G4-B5	BGA	0	1.63	0.99	1.14	0.28	0.49	0.31	0	1.24	2.14	0	0.95	0.96	1.85	0.94	1.22
G4-B5	Header	0	0.82	1.01	0.55	0.19	0.07	0.05	0	0.77	0.42	0	0.15	0.47	0.66	0.78	0.51

Table 4: IC results for Group 4.

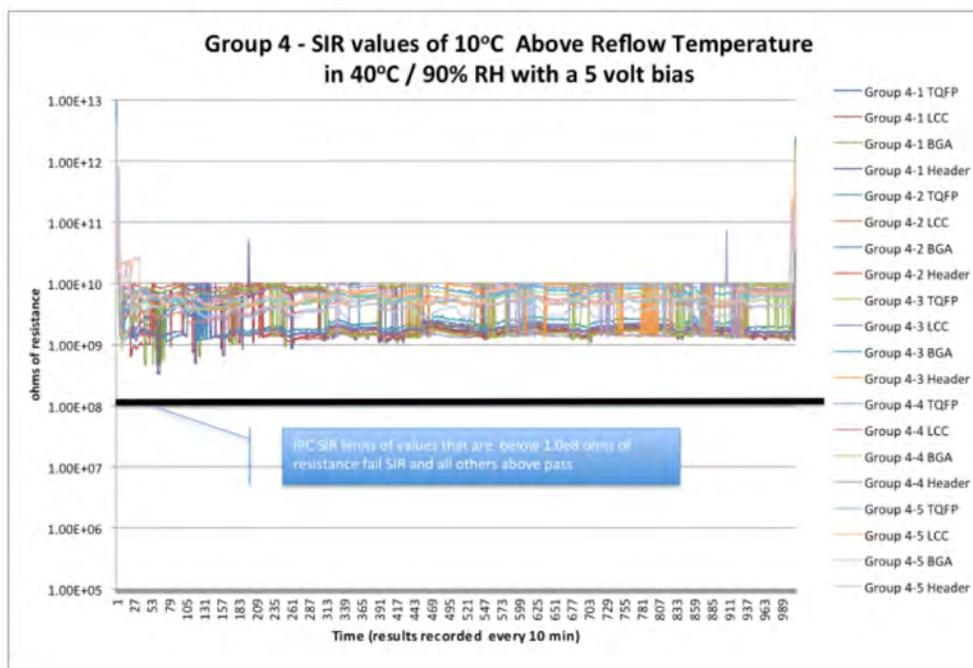


Figure 10: SIR results for Group 4.

tors, voltage easily flows between the two. When processing assemblies with a water-soluble flux, or when cleaning no-clean flux, there is a failsafe for removing the conductive residues. Processing with no-clean flux types does not allow for any excess of contamination from any of the selected materials such as PCBs and components. One of the few things that can be controlled in an effort to reduce overall cleanliness and quality is the reflow process.

Future Work

With the myriad of different no-clean flux formulas, a larger study that includes more types is in order to determine the effect of thermal energy on different types of chemistry used as flux activators. **SMT007**



Eric Camden is a lead investigator at Foresite Inc. To read past columns or contact Camden, [click here](#).



PROTOTRON.COM
(888)847-7686

Your Passport to Global PCB Sourcing

We are pleased to announce that with the same fine service, quality, delivery and attention to detail that our customers have grown to rely upon, we are now adding a complete global solution to meet all of your needs, both today and in the future.

Our Solutions:

- *FLEX & RIGID-FLEX*
- *HDI / MICROVIA*
- *COMPETITIVE VOLUME PRICING*
- *PRE-QUALIFIED OFFSHORE PARTNERS*
- *QUICK-TURN PROTOTYPES*
- *COMPLEX MULTILAYER*
- *MIL-SPEC PRODUCTION*
- *SPECIALTY MATERIALS*

MORE INFO
Global PCB Sourcing
PDF DOWNLOAD



FREE BOOK
DOWNLOAD
I-007eBooks.com



Prototron Circuits

A COMPLETE GLOBAL SOLUTION

REDMOND, WASHINGTON • TUCSON, ARIZONA • GLOBAL PARTNERSHIPS



Supplier Highlights



Electronic Manufacturing Files: What We Need for PCB Assembly ▶

As PCB assemblers, manufacturing is all about taking data and delivering good working circuit boards. It can be just data, as in full turn-key, data plus some parts, or a partial turn-key or a kitted job. Regardless of whether you're sending parts and boards or having us buy everything, PCB assemblers need good data, and a lot of it.

SMT Electrolytic Capacitor Solder Joint Criteria and Integrity Investigation ▶

The body configuration of SMT electrolytic capacitors results in the solder joints being only partially visible for optical inspection purposes. Therefore, the use of adequate reflow soldering processes is critical for producing solder joints that are acceptable for their end-product use environment.

Overcoming the Challenges of Miniaturization with New Stencil Technologies, Part 1: Solder Paste Release ▶

Product miniaturization continues to challenge capabilities in both design and manufacturing in the surface-mount assembly process and has the potential to increase first-pass defects more than ever. Looking at these first-pass defects, time and time again, the solder paste printing process is identified as the largest contributor. This two-part column will look at solder paste release during printing, and how new stencil technologies can reduce first-pass defects.

Electrolube on Managing Thermal Interfaces and Conformal Coatings ▶

Electrolube's Jade Bridges, global technical support manager, speaks with I-Connect007 Technical Editor Pete Starkey about how to

manage thermal management interfaces for maximum heat transfer efficiency. She also provides an update on conformal coatings.

Dr. Cortney Baker to Keynote WIE Reception at IPC APEX EXPO ▶

Dr. Cortney Baker, nationally recognized authority on women in leadership, will speak at the IPC APEX EXPO Women in Electronics reception on Wednesday, January 30, 2019, 6:00-7:00 p.m.

Powerful Prototypes: What Is Your Supply Chain Telling You About Components? ▶

Right now, many, many parts are in short supply, or unavailable with extraordinarily long lead times. Allocation is the word of the day and substitutions are your friend. Sure, electronics components shortage happens every now and then in this industry. It's a periodic nuisance, but what should you do for the long term? Read on.

Understanding the Benefits of CFX ▶

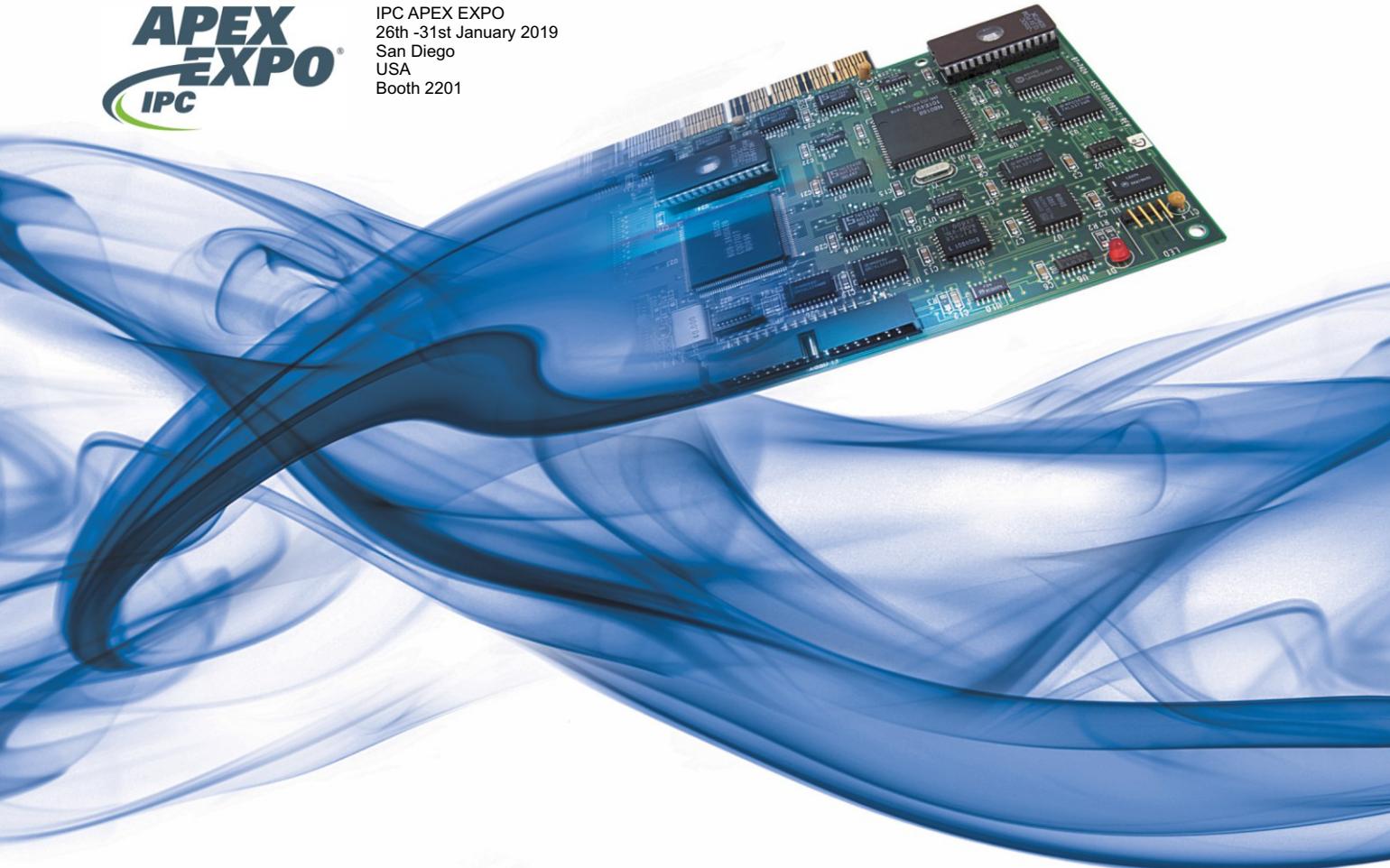
In an interview with *SMT007 Magazine*, David Fenton, group customer support manager for Blakell Europlacer, discusses the technical challenges and the impact of the IPC Connected Factory Exchange (CFX) initiative on the PCB assembly industry, and what manufacturers can expect from this electronics assembly connectivity standard.

How to Avoid Supply Chain Disruption this Chinese New Year ▶

To avoid any negative impact on deliveries or lead-times during the Chinese New Year, the best tactic is to start planning early. And while there's no need to panic buy, you'll definitely want to think ahead when communicating with your PCB suppliers.



IPC APEX EXPO
26th -31st January 2019
San Diego
USA
Booth 2201



Advancing the applications of conformal coatings

Our knowledge of the wider industry, combined with our ever advancing approaches to research and development, have created a range of Conformal Coatings with the necessary high performance and reliability required for the military, aerospace and commercial industries.

Although every electro-chemical solution is in our spectrum, our specialist approach to problems has established us as a key provider and developer to the technical electrical industry, both commercial and domestic.

Isn't it time you discovered out how Electrolube can serve you?
Simply call, or visit our website.

Tel: 888-501-9203

www.electrolube.com



Scan the code to discover our full spectrum of superior Conformal Coatings and electro-chemical solutions.

ELECTROLUBE
THE SOLUTIONS PEOPLE

Electronic & General
Purpose Cleaning

Conformal
Coatings

Encapsulation
Resins

Thermal Management
Solutions

Contact
Lubricants

Maintenance
& Service Aids

How Much is Too Much?

Knocking Down the Bone Pile
by Bob Wettermann, BEST INC.

One of the typical questions process engineers pose regarding the PCB rework process is, “How many heat cycles are too much?” Asked in another way, the question is, “How would one define a limit on the number of times a PCB can be reworked while still being reasonably assured that the reliability has not been impacted based on its operational environment?”

The answer will depend on a multitude of factors, but it is largely influenced by the board’s function in the end-use operating environment. For example, a plane control module that is protecting passengers while in flight (Class 3) has a different set of maximum conditions compared to a giveaway toy that came from the local fast food eatery (Class 1).

In reviewing this topic, consider that rework cycles consume part of the useful thermomechanical life of the PCB.

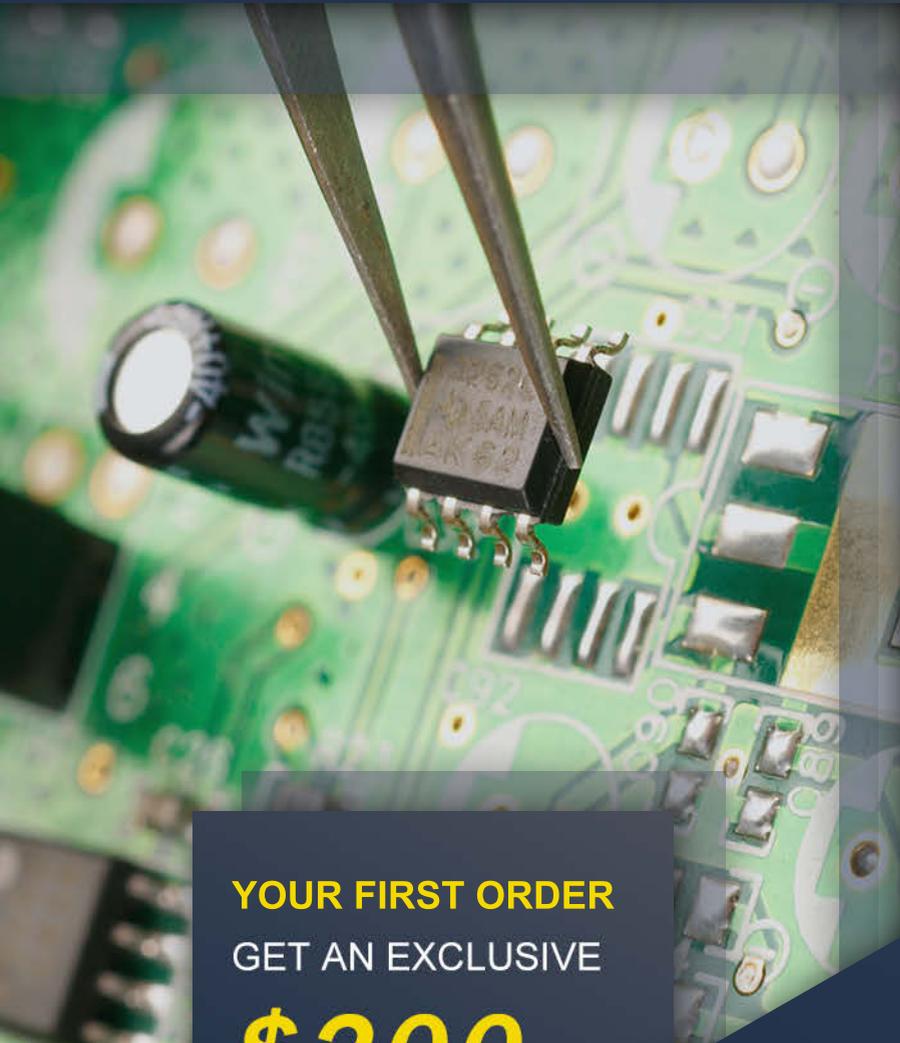
There are several factors to consider when calculating the maximum number of allowable rework cycles. Some of the most relevant factors include PCB design, materials (including the components involved in the design of the PCB), and the number of heat cycles or heating and cooling cycles the board has experienced. The multitude of factors and there being no one number is also supported in the rework and repair guidelines document, IPC-7711/21, which states as follows, “This document does not limit the maximum number of rework, modification, or repair actions to a printed circuit assembly.”

PCB design has an impact on how the many cycles should be allowed for rework. There are hearty laminates that can take multiple heat cycles. Higher layer-count PCBs with high aspect ratios through vias are more prone to failure after only a few soldering cycles if the materials of construction are not robust. In general, larger pads hold up under more heat cycles; however, with smaller pads, there is a greater chance of board delamination after only a few cycles. Testing and



Figure 1: How many times should I attempt to rework a PCB?

Get Your PCBs Assembled within Budget and Time Schedule



PCBCart's Consigned & Turnkey PCB Assembly services let you get fully assembled circuit boards at lightning speed and low cost without compromising quality.

We manage project from concept to delivery and make the entire assembly process as seamless and smooth as possible, saving you from dealing with multiple vendors and allowing you more time on project engineering & marketing issues.

YOUR FIRST ORDER
GET AN EXCLUSIVE

\$200

DISCOUNT!

Our Advantages:

- Flexible Volume: Prototypes, low volume, high volume
- Multiple Assembly Technologies: SMT, THT, Mixed Assembly
- Multiple Components Selection: Thru-hole, BGA, QFN, 01005, 0201...
- Multiple Value-added options: Free DFM Check, AOI, AXI...



experimentation via life cycle testing will show what is right for your specific application and end-use operating environment. A well-chosen material set will, in most cases, withstand up to six heat cycles (three rework cycles) for the majority of Class-2 or Class-3 designs.

The materials included in the design of the PCB (including the components and boards) have an impact on the maximum number of rework or heat cycles that an electronics assembly can withstand. As a reminder, an entire assembly can be compromised if only a single component is damaged. Make sure to look up the specifications for all of the components to investigate the temperature limit specified by the component manufacturer. It's important to note here that passive components may have a lower time-over-temperature exposure limit than larger active components. This is known in the component specification world as the process sensitivity level (PSL). Furthermore, check what these values mean for other elements on a PCB, which are further defined in the IPC J-STD-075: Classification of Non-IC Electronic Components for Assembly Processes. During a reflow process, the board is stressed as well as the solder joints and all of the components.

The total number of heat and cooling cycles should be part of the decision to limit the number of rework cycles. In general, the typical number of rework attempts (multiply by two to get to the number of heat cycles) for Class-2 and Class-3 PCBs is three. Make sure to enumerate all of the heat cycles the board has already gone through. For a typical double-sided PCB, this could include both the primary side component placement and reflow as well as the secondary side placement and reflow.

Develop a profile for each of the processes using a thermal profiler to prove that you have not exceeded any of the component temperature/time limits. If we simply remove and replace one of the devices, then the count of reflow cycles already numbers four. For BGAs and other active devices, the usual number of heat excursions is equal to the number of times the die is exposed to the liquidus temper-

ature of the soldering alloy used. However, wave soldering, baking, and conformal coating curing processes may heat and relax the PCB. If reballing of the device is required, then another two heat cycles—one for the removal of the BGA balls and the other for the re-attachment reflow—must be added to the total. There are some ball removal processes that do not raise the die temperature above liquidus.

In addition to the technical limitations placed on the maximum number of rework cycles, there are also economic decisions that may drive the cost versus benefit of a rework process. Many times, the alternatives evaluated include the removal and replacement of the device or scrapping the board and replacing with a new assembly. At times, the cost and availability of these options push the decision in a certain direction. PCB rework yields, overhead costs, and opportunity costs in using labor (which could be producing higher margin PCBs) enter the decision-making process. Thus, the question that needs to be answered is, “When is too much too much?” **SMT007**

Further Reading

1. IPC—Association Connecting Electronics Industries. “IPC-7711/21: Rework, Modification, and Repair of Electronic Assemblies.” November 1, 2011.
2. Coyle, R., Meilunas, M., Popowich, R., Anselm, M., Read, P., Oswald, M., & Fleming, D. “Interconnection Reliability of Interposer and Reballing Options for BGA Backward Compatibility.” SMTA International proceedings, October 14, 2012.
3. Ma, H., Xie, W., Subbarayan, G., & Lieu, K.C. “Effects of Multiple Rework on the Reliability of Lead-free Ball Grid Array Assemblies.” IEEE 61st Electronic Components and Technology Conference, 2011.



Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago. To read past columns or contact Wettermann, [click here](#).

WHAT DO ALL OF THESE LEADING COMPANIES HAVE IN COMMON?



They all benefit by advertising with us—PCB007 China Magazine.

Should your name be on the leaders' list?



GET STARTED NOW!

I-Connect007
GOOD FOR THE INDUSTRY



pcb007china.com

The Fourth Pillar of Defense Acquisition: **Cybersecurity**

Mil/Aero Markets
by John Vaughan, ZENTECH

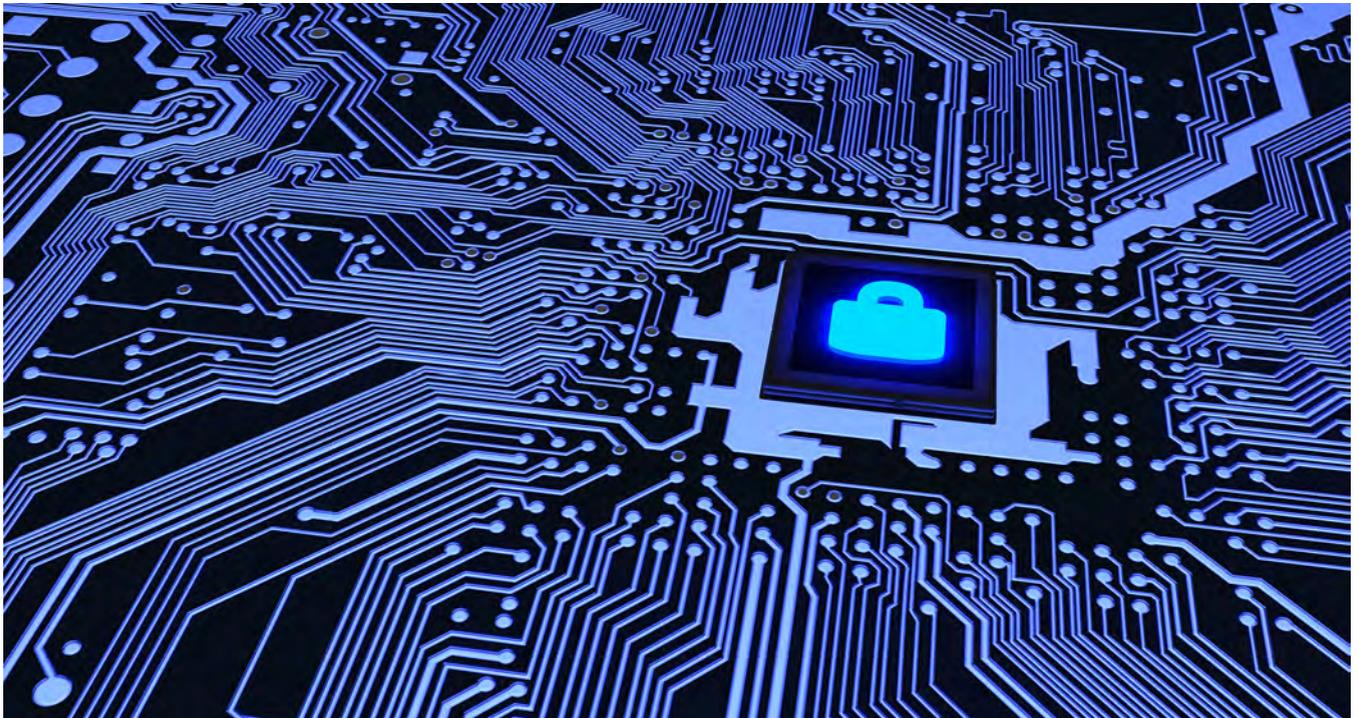
If you are a provider of PCBs and/or electronics manufacturing services to the Department of Defense (DoD) and their prime contractors, you have no doubt noticed a significant increase in the number of Defense Federal Acquisition Regulation Supplement (DFARS) flow-downs, scrutiny of your data management, audits of your cybersecurity processes, and inquiries into the status of your compliance with a variety of cybersecurity initiatives.

There has been a constant flow of reports and initiatives over the past two years that point directly to increased emphasis on cybersecurity by the DoD within the Defense Industrial Base Supply Chain. These reports all

coalesce around further strengthening critical cybersecurity programs and initiatives within the DoD and provide the roadmap to compliance and elevating your organization to position for continued participation in the defense sectors of our industry.

We have clearly entered a paradigm shift, with cybersecurity now joining cost, schedule, and performance as the Fourth Pillar of Defense Acquisition.

Referencing the DoD “Deliver Uncompromised” pilot program mandated by the National Defense Appropriations Act (NDAA) and the associated MITRE Corporation study from August 2018 ^[1], the first course of action (COA) detailed is to elevate security as a primary



A BETTER IDEA



Valor[®] NPI DFM JUST GOT EASIER!

Valor NPI software is industry's only automated PCB DFM solution, seamlessly connecting PCB design, fabrication, assembly and test processes.

With the latest version of Valor NPI, setup time for DFM rules can be reduced from weeks to days, and DFM results viewing time can be reduced by up to 50 percent.

LEARN MORE AT [HTTP://WWW.MENTOR.COM/NPI](http://www.mentor.com/npi)

Mentor[®]

**APEX
EXPO[™]**
IPC 2019
BOOTH # 1900

A Siemens Business

metric in the DoD acquisition and sustainment process. The report states:

- It is vital to “Deliver Uncompromised” that security have equal status to cost, schedule, and performance
- The revision of DoD 5000.02 (Operation of the Defense Acquisition System) to make security the “Fourth Pillar” of acquisition planning—equal in emphasis to cost, schedule, and performance
- Utilize acquisition tools and contract leverage and reinforce the objective of “Deliver Uncompromised” through the use of positive and negative incentives

Encouragingly, there is also language in the report that recognizes there are hard costs associated with the DoD supply chain implementing the requisite cybersecurity measures, and several tax incentive measures are detailed for consideration, further analysis, and discussion to offset the costs.

The key takeaway is that all PCB fabricators and electronics manufacturing service providers providing electronics products to the defense sector need to immediately heighten awareness and proactively address cybersecurity if they desire to continue supporting the DoD and their prime contractors.

In terms of the actual gates in the evaluation process that all proffers to the DoD will soon be subjected to a “go, no-go” initial bid analysis that evaluates cybersecurity hardening as the first gate to pass through for offers to be considered before the long-standing DoD contracts analysis process evaluating quality, cost, schedule appears most logical to me.

In September 2018, the “Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806” was released. Titled “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States,” it is an in-depth and fascinating look at the defense industrial base including PCBs and circuit card assemblies for DoD systems [2].

In Section VI of the report, “Ten Risk Archetypes Threatening America’s Manufacturing and Industrial Base,” we find more compelling direction and comment that underscores the threat that cyber-related crime poses to our national security.

Quoting the report, “The defense manufacturing supply chain flows goods and critical supporting information through multiple organizations of varying size and sophistication to transform raw materials into components, subassemblies, and ultimately, finished products and systems that meet DoD performance specifications and requirements. These supply chains rely upon an infinite number of touch points where digital and physical information flows through multiple networks both within and across manufacturers systems. In today’s digitized world, every one of these supply chain touch points represents a potential product security risk.”

In today’s digitized world, every one of these supply chain touch points represents a potential product security risk.

In addition to data breaches, it is also noteworthy to point out that The Department of Homeland Security (DHS) reported that the critical manufacturing sector reported the highest number of cyber attacks on industrial control systems of any critical infrastructure sector with numerous threats emerging that had the potential to cause major disruption in manufacturing operations.

With the publication of the 2018 National Defense Strategy [3], U.S. Secretary of Defense General Jim Mattis stated, “Challenges to the U.S. military advantage represent another shift in the global security environment. For decades, the United States has enjoyed uncontested or dominant superiority in every operating domain. We could generally deploy our

IPC Global Marketplace

Delivers Intelligent Search Technology

IPC Global Marketplace is an innovative buyer's guide that enables electronics industry professionals to easily locate the products and services they need to effectively run their business.

With its intelligent search technology, mobile responsive design, and enhanced company profiles, IPC Global Marketplace take the user experience to the next level, all while putting your company in front of the "right" professionals in our industry. It's the place to see and be seen.



IPC Global Marketplace is available on IPC's website, www.ipc.org or directly through ipcglobalmarketplace.com.

forces when we wanted, assemble them where we wanted, and operate how we wanted. Today, every domain is contested—air, land, sea, space, and cyberspace.”

In June 2016 (and as amended August 2018), the U.S. Secretary of Defense established the Printed Circuit Board and Interconnect Technology Executive Agent (PrCB EA) via DoD Instruction 5101.18E ^[4] with an original National Academy charter to develop a competitive network of trusted suppliers.

To this end—and in a collaborative effort between IPC, the PrCB Executive Agent (NSWC-Crane), DoD, and other government and industry partners—IPC-1791 was developed to complement and expand the integrity assurance offered by the Trusted Access Program Office (TAPO) for microelectronics to address integrity assurance vulnerabilities related to the design, fabrication, and assembly of printed boards with initial emphasis on defense requirements.

The IPC-1791 (August 2018) standard, “Trusted Electronic Designer, Fabricator and Assembler Requirements” provides minimum requirements, policies, and procedures for printed board design, fabrication, and assembly organizations and/or companies to become trusted sources for markets requiring high levels of confidence in the integrity of delivered products. These trusted sources shall ensure quality, supply chain risk management (SCRM), security, and chain of custody (ChoC).

Expect to hear a lot about the IPC-1791 standard at IPC APEX EXPO in San Diego (January 26–31). If your company is involved in support of military electronics manufacturing, I would highly encourage you to attend to learn more.

In closing, I have had the pleasure and honor to serve on both the National Defense Industrial Association (NDIA) Executive Order 13806 Electronics Working Group and the IPC Trusted Supplier Task Group over the past two years as many of these initiatives and standards have evolved. Serving with many others from the electronics industry, DoD, Commerce, and beyond, I have devel-

oped an incredible respect for all principals involved, and have witnessed first-hand their hard work, leadership, deep thinking, and unwavering dedication to providing a framework to protect our nation’s most sensitive defense information.

Electronics, and the associated electronic manufacturing supply chain, are key components of all military systems. As such, our industry has a responsibility to both embrace and solve for the challenges associated with secure management of the vast amount of sensitive technical data that flows through our organizations’ networks and within our supply chains.

Our nation’s security depends on the electronics industry performing at a high-level regarding cybersecurity, and there is compelling evidence to suggest that the ability of your company to continue to support DoD electronics manufacturing also depends upon it. **SMT007**

References

1. Nissen, C., Gronager, J., Metzger, R., & Rishikof, H. “[Deliver Uncompromised: A Strategy for Supply Chain Security and Resilience in Response to the Changing Character of War.](#)” MITRE Corporation, August 2018.
2. Office of the Under Secretary of Defense for Acquisition and Sustainment, and the Office of the Deputy Assistant Secretary of Defense for Industrial Policy. “[Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States: Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806.](#)” September 2018.
3. United States Department of Defense. “[Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military’s Competitive Edge.](#)” 2018.
4. Office of the Under Secretary of Defense for Acquisition and Sustainment. “[DoD Directive 5101.18E: DoD Executive Agent for Printed Circuit Board and Interconnect Technology.](#)” June 12, 2016.



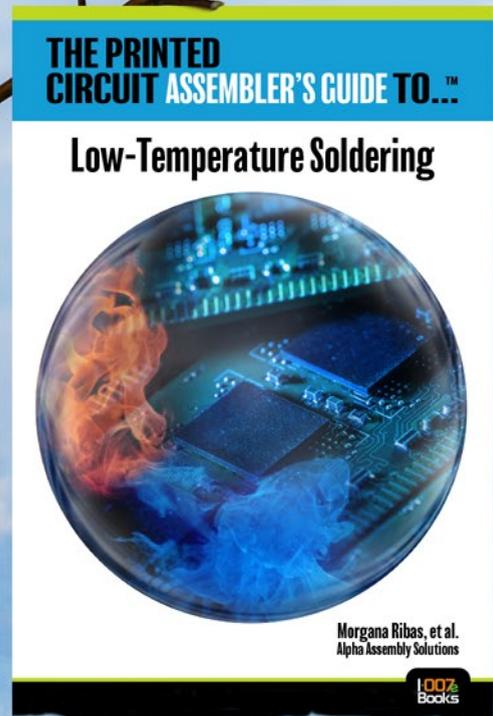
John Vaughan is VP of Zentech (Baltimore, Maryland) and is a widely recognized subject matter expert (SME) in military C5ISR electronics. To read past columns or contact Vaughan, [click here](#).

Get heat relief with low-temperature soldering!

Do you smell carrots?



I-007eBooks.com



Download Now!



Editor's Picks from SMT07.com

1 **Tempo Automation's Open House Raises the Curtain in San Francisco** ▶

Based in San Francisco, Tempo Automation specializes in rapid PCB assembly and on low volume production for a wide range of board complexities. It recently held an open house at its brand-new facility in the South of Market (SoMa) district—which is normally restricted under customer non-disclosure agreements as well as International Traffic in Arms Regulations (ITAR) regulations—to customers, vendors, local designers, and government officials.

2 **3D Printing and Medical Electronics: A Disruptive Beneficial Technology** ▶

We are seeing significant advances and increased uses for 3D manufacturing in medicine—many more than 3D-printed and conductive circuits on device structural components. There is enough movement in this area that 3D additive fabrication in medicine—including but not limited to 3D-printed circuits—has become its own topic, and one that we will be watching and continuing to cover.

3 **Quest for Reliability: Does Medical Device Reliability Worry You Sick?** ▶

When you are manufacturing high-reliability assemblies related to medical industry, it is critical to take a very close look at the assembly process and all other processes that can influence the end-use reliability—even seemingly unrelated processes, such as post-installation cleaning—as it really could be a matter of life or death.



Eric Camden

4 **Electronic Manufacturing Files: What We Need for PCB Assembly** ▶

As PCB assemblers, manufacturing is all about taking data and delivering good working circuit boards. It can be just data, as in full turn-key, data plus some parts, or a partial turn-key or a kitted job. Regardless of whether you're sending parts and boards or having us buy everything, PCB assemblers need good data, and a lot of it.

5 SMT Electrolytic Capacitor Solder Joint Criteria and Integrity Investigation ▶

The body configuration of SMT electrolytic capacitors results in the solder joints being only partially visible for optical inspection purposes. Therefore, the use of adequate reflow soldering processes is critical for producing solder joints that are acceptable for their end-product use environment.

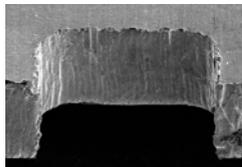


6 EMS Installs Two Panasonic NPM-W2 Machines ▶

Electronic Manufacturing Solutions Limited (EMS) has installed two new Panasonic NPM-W2 machines.

7 Overcoming the Challenges of Miniaturization with New Stencil Technologies, Part 1: Solder Paste Release ▶

Product miniaturization continues to challenge capabilities in both design and manufacturing in the surface-mount assembly process and has the potential to increase first-pass defects more than ever. Looking at these first-pass defects, time and time again, the solder paste printing process is identified as the largest contributor. This two-part column will look at solder paste release during printing, and how new stencil technologies can reduce first-pass defects.



8 Rehm Seminar in Korea Draws a Crowd ▶

Topics such as Industry 4.0, China Smart Manufacturing 2025, Artificial Intelligence and the Internet of Things are currently heavily influencing the evolution of traditional manufacturing.



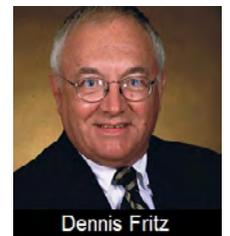
9 Smart Factory a Reality: IPC APEX EXPO 2019 Hosts Two Production Lines ▶

Creating the next generation of digital Industry 4.0 technology standards, IPC will again take a major step forward at IPC APEX EXPO 2019, featuring two live production lines, at which visitors can see and experience achievements made in digital standards development over the past year.



10 Defense Speak Interpreted: PERM-Pb-free Electronics Risk Management ▶

In this column, we explore PERM—the Pb-free Electronics Risk Management Consortium. No, the group members do not all have curly hair! The name was chosen around 2008 by a group of engineers from aerospace, defense, and harsh environment (ADHE) organizations.



For the latest news and information, visit SMT007.com. Subscribe to our newsletters or premium content at [my I-Connect007](http://myI-Connect007.com).

Career Opportunities

Pssst!
**Are You Looking
for Someone?**



Place your notice in our Help Wanted section.

For just \$500, your 200 word, full-column—or, for \$250, your 100 word, half-column—ad will appear in the Help Wanted section of all three of our monthly magazines, reaching circuit board designers, fabricators, assemblers, OEMs and suppliers.

Potential candidates can click on your ad and submit a résumé directly to the email address you've provided. If you wish to continue beyond the first month, the price is the same per month. No contract required. We even include your logo in the ad, which is great branding!

To get your ad into the next issue, contact:

Barb Hockaday at barb@iconnect007.com or +1.916.608.0660 (-7 GMT)

I-Connect007
GOOD FOR THE INDUSTRY



Career Opportunities



SMT Operator Huntingdon Valley, PA

Manncorp, a leader in the electronics assembly industry, is looking for a technician to operate our new in-house SMT LED assembly lines.

Duties and Responsibilities:

- Set up and operate automated SMT assembly equipment
- Prepare component kits for manufacturing
- Perform visual inspection of SMT assembly
- Participate in directing the expansion and further development of our SMT capabilities

Requirements and Qualifications:

- Prior experience with SMT equipment, or equivalent technical degree preferred
- Basic computer knowledge
- Proven strong mechanical and electrical troubleshooting skills
- Experience programming machinery or demonstrated willingness to learn
- Positive self-starter attitude with a good work ethic
- Ability to work with minimal supervision

We Offer:

- Paid training period
- Health and dental insurance
- Retirement fund matching
- Continuing training

[apply now](#)



SMT Field Technician Huntingdon Valley, PA

Manncorp, a leader in the electronics assembly industry, is looking for an additional SMT Field Technician to join our existing East Coast team and install and support our wide array of SMT equipment.

Duties and Responsibilities:

- Manage on-site equipment installation and customer training
- Provide post-installation service and support, including troubleshooting and diagnosing technical problems by phone, email, or on-site visit
- Assist with demonstrations of equipment to potential customers
- Build and maintain positive relationships with customers
- Participate in the ongoing development and improvement of both our machines and the customer experience we offer

Requirements and Qualifications:

- Prior experience with SMT equipment, or equivalent technical degree
- Proven strong mechanical and electrical troubleshooting skills
- Proficiency in reading and verifying electrical, pneumatic, and mechanical schematics/drawings
- Travel and overnight stays
- Ability to arrange and schedule service trips

We Offer:

- Health and dental insurance
- Retirement fund matching
- Continuing training as the industry develops

[apply now](#)

Career Opportunities



ventec
INTERNATIONAL GROUP
騰輝電子

Technical Support Engineer, Germany

We are looking for a technical support engineer to join our team at our German facility in Kirchheimbolanden. The successful candidate will assist potential and current customers in appreciating the benefits of using and optimizing the use of Ventec materials in their PCB manufacturing processes, enhance customer loyalty and satisfaction, spread the use of Ventec materials, and grow sales. The technical support engineer will provide a two-way channel of technical communication between Ventec's production facilities and U.K./European customers.

Skills and abilities required for the role:

- Scientific and technical educational background
- Experience in the PCB industry in engineering and/or manufacturing
- Strong communications skills (German and English) with the ability to write full technical reports for group or customer distribution
- Ability to work in an organized, proactive, and enthusiastic way
- Ability to work well both in a team as well as an individual
- Good user knowledge of common Microsoft Office programs
- A full driving license is essential
- Willingness to travel regularly throughout Europe and occasionally to Asia

We offer:

- Excellent salary and benefits commensurate with experience

This is a fantastic opportunity to become part of a successful brand and leading team with excellent benefits.

Please forward your resume to
applytoventec@ventec-europe.com

apply now



ventec
INTERNATIONAL GROUP
騰輝電子

Technical Sales Engineer, Germany

Want to advance your career by joining our globally successful and growing world-class CCL manufacturing company and help drive that success? Tasked with driving sales in the German-speaking markets, you will be a key member of the technical sales team. Your focus will be on Ventec's core market segments: military/aerospace, automotive, and medical offering a full range of high-reliability materials including polyimide, IMS, and thermal management products.

Skills and abilities required for the role:

- Seven to 10 years of experience in the PCB industry in engineering and/or manufacturing
- Strong communications skills (German and English)
- Project management experience
- Detail-oriented approach to tasks
- Ability to manage tasks and set goals independently as well as part of a team
- Knowledge of Microsoft Office products
- A full driving license is essential.
- Willingness to travel regularly throughout Europe and occasionally to Asia

We offer:

- Excellent salary and benefits commensurate with experience

This is a fantastic opportunity to become part of a successful brand and leading team with excellent benefits.

Please forward your resume to
applytoventec@ventec-europe.com

apply now

Career Opportunities



Field Service Engineer West Coast

Pluritec North America, Ltd., An innovative leader in drilling, routing and Automated Inspection in the Printed Circuit Board industry, is seeking a full-time Field Service Engineer, located on the West Coast.

This individual will support service for North America in Equipment installation, training, maintenance and repair. Candidate must be able to handle trouble shooting electronic and mechanical issues as well customer applications in the field. A technical degree is preferred, along with strong verbal and written communication skills. The position requires the ability to travel 2-3 weeks per month.

Please send your resume to:
Carolina.zepieri@pluritec.org

[apply now](#)



Sales Personnel, Japan

The Gardien Group is looking to expand the sales team in Tokyo, Japan, and seeking highly motivated team players with a positive attitude. Prior experience in the PCB industry is an advantage but not necessary for the right candidate.

The role involves working closely with the customer to identify their needs and deliver the right solution. The candidate should be able to offer a high level of customer satisfaction to ensure ongoing sales.

Training will be provided along with a competitive benefits package, excellent growth opportunities, and periodic bonuses.

Interested candidates, please contact us at careers.jp@gardien.com with your resume.

Kindly note only shortlisted candidates will be notified.

[apply now](#)

Career Opportunities



U.S. CIRCUIT

Sales Representatives (Specific Territories)

Escondido-based printed circuit fabricator U.S. Circuit is looking to hire sales representatives in the following territories:

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

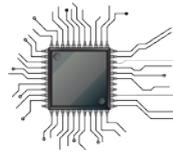
Compensation:

- 7% commission

Contact Mike Fariba for more information.

mfariba@uscircuit.com

apply now



MivaTek

Global

Multiple Positions Available

Want to work for a fast-growing company? MivaTek Global may be the place for your next career move. 2018 has brought significant growth, increasing sales and revenue. And, we are just getting started! To support the current customer base and fuel further expansion, we are looking for bright and talented people who are energized by hard work in a supportive and flexible environment.

Open Positions:

- Technical Service Technicians
- Regional Sales Representatives
- Regional Leader for Asia Sales and Support

Proven experience in either PCB or Microelectronics and willingness to travel required for all positions.

More About Us

MivaTek Global is a distributor of manufacturing equipment with an emphasis of Miva Technologies' Direct Imager, Mask Writer, Flatbed Photo-plotter imaging systems and Mach3 Labs X-Ray Drills. We currently have 45 installations in the Americas. Expansion into Asia during 2018 has led to machine installations in China, Singapore, Korea, and India.

To be part of our team, send your resume to n.hogan@kupertek.com for consideration of current and future opportunities.

apply now

Career Opportunities



MacDermid Enthone
ELECTRONICS SOLUTIONS

Global Application Specialist Waterbury, CT

Qualifications: Bachelor's in Chemistry, and seven years progressive experience in related field. Expertise preferably in ENIG and ENEPIG. Global travel required: up to 40%.

Responsibilities

- Chemical analysis and experiments of final finish chemistries; characterize new processes from research prior to beta site installations, establishing operating parameters, problem solving tools and analytical guidelines.
- Recommend product, process, and analytical method improvements; including changing composition of compounds.
- Develop final finish product line. Install products at beta sites; collect data.
- Lead technical teams during beta site installations of new products and problem-solving groups at customer locations.
- Train personnel.
- Set up tests of final finish chemistries and products for laboratory personnel to identify customer problems, analyze result to resolve customer issues, and communicate results to customers.
- Oversee laboratory analysis and processing of customer samples through our global technical centers; summarize data, make recommendations and write reports.
- Document technical bulletins.

MacDermid Enthone is an E-Verify Company and provides reasonable accommodation for qualified individuals with disabilities and disabled veterans in job applicant procedures. "Equal Opportunity Employer: Minority/Female/Veteran/Disabled/Gender Identity/Sexual Orientation."

apply now

ELECTROLUBE

THE SOLUTIONS PEOPLE

We Are Recruiting!

A fantastic opportunity has arisen within Electrolube, a progressive global electro-chemicals manufacturer. This prestigious new role is for a sales development manager with a strong technical sales background (electro-chemicals industry desirable) and great commercial awareness. The key focus of this role is to increase profitable sales of the Electrolube brand within the Midwest area of the United States; this is to be achieved via a strategic program of major account development and progression of new accounts/projects. Monitoring of competitor activity and recognition of new opportunities are also integral to this challenging role. Full product training to be provided.

The successful candidate will benefit from a generous package and report directly to the U.S. general manager.

Applicants should apply with their CV to
melanie.latham@hkw.co.uk
(agencies welcome)

apply now

Career Opportunities



ZENTECH

Zentech Manufacturing: Hiring Multiple Positions

Are you looking to excel in your career and grow professionally in a thriving business? Zentech, established in Baltimore, Maryland, in 1998, has proven to be one of the premier electronics contract manufacturers in the U.S.

Zentech is rapidly growing and seeking to add Manufacturing Engineers, Program Managers, and Sr. Test Technicians. Offering an excellent benefit package including health/dental insurance and an employer-matched 401k program, Zentech holds the ultimate set of certifications relating to the manufacture of mission-critical printed circuit card assemblies, including: ISO:9001, AS9100, DD2345, and ISO 13485.

Zentech is an IPC Trusted Source QML and ITAR registered. U.S. citizens only need apply.

Please email resume below.

[apply now](#)

Mentor®

A Siemens Business

PCB Manufacturing, Marketing Engineer

Use your knowledge of PCB assembly and process engineering to promote Mentor's Valor digital manufacturing solutions via industry articles, industry events, blogs, and relevant social networking sites. The Valor division is seeking a seasoned professional who has operated within the PCB manufacturing industry to be a leading voice in advocating our solutions through a variety of marketing platforms including digital, media, trade show, conferences, and forums.

The successful candidate is expected to have solid experience within the PCB assembly industry and the ability to represent the Valor solutions with authority and credibility. A solid background in PCB Process Engineering or Quality management to leverage in day-to-day activities is preferred. The candidate should be a good "storyteller" who can develop relatable content in an interesting and compelling manner, and who is comfortable in presenting in public as well as engaging in on-line forums; should have solid experience with professional social platforms such as LinkedIn.

Success will be measured quantitatively in terms of number of interactions, increase in digital engagements, measurement of sentiment, article placements, presentations delivered. Qualitatively, success will be measured by feedback from colleagues and relevant industry players.

This is an excellent opportunity for an industry professional who has a passion for marketing and public presentation.

Location flexible: Israel, UK or US

[apply now](#)

Career Opportunities



BLACKFOX

Premier Training & Certification

IPC Master Instructor

This position is responsible for IPC and skill-based instruction and certification at the training center as well as training events as assigned by company's sales/operations VP. This position may be part-time, full-time, and/or an independent contractor, depending upon the demand and the individual's situation. Must have the ability to work with little or no supervision and make appropriate and professional decisions. Candidate must have the ability to collaborate with the client managers to continually enhance the training program. Position is responsible for validating the program value and its overall success. Candidate will be trained/certified and recognized by IPC as a Master Instructor. Position requires the input and management of the training records. Will require some travel to client's facilities and other training centers.

For more information, click below.

[apply now](#)



YOUR
JOB
AD
HERE

For information, please contact:
BARB HOCKADAY
barb@iconnect007.com
+1 916.365.1727 (PACIFIC)

I-Connect007
GOOD FOR THE INDUSTRY



Events Calendar

48th NEPCON JAPAN ▶

January 16–18, 2019
Tokyo, Japan

IPC APEX EXPO 2019 Conference and Exhibition ▶

January 26–31, 2019
San Diego, California, U.S.

DesignCon 2019 ▶

January 29–31, 2019
Santa Clara, California, U.S.

SMTA Pan Pacific Microelectronics Symposium ▶

February 11–14, 2019
Kauai, Hawaii, U.S.

EIPC 2019 Winter Conference ▶

February 14–15, 2019
Milan, Italy

China International PCB & Assembly Show (CPCA Show 2019) ▶

March 19–21, 2019
Shanghai, China

MicroTech 2019 ▶

April 4, 2019
Cambridge, U.K.

Medical Electronics Symposium 2019 ▶

May 21–22, 2019
Elyria, Ohio, U.S.

Additional Event Calendars



Coming to SMT007 Magazine:

FEBRUARY: SELLING YOUR SERVICES

A look at strategies to help you improve how you sell your electronics manufacturing and PCB assembly services.

MARCH: HIRING, TRAINING, AND STAFFING

We explore how fabricators are changing their recruiting, staff development, and manufacturing practices to adapt to the 21st Century.

PUBLISHER: **BARRY MATTIES**
barry@iconnect007.com

SALES MANAGER: **BARB HOCKADAY**
(916) 608-0660; barb@iconnect007.com

MARKETING SERVICES: **TOBEY MARSICOVETERE**
(916) 266-9160; tobey@iconnect007.com

MANAGING EDITOR: **NOLAN JOHNSON**
(503) 597-8037; nolan@iconnect007.com

CONTRIBUTING EDITOR: **STEPHEN LAS MARIAS**
+63 906 479 5392; stephen@iconnect007.com

TECHNICAL EDITOR: **PETE STARKEY**
+44 (0) 1455 293333; pete@iconnect007.com

ASSOCIATE EDITOR: **KIERSTEN ROHDE**
kiersten@iconnect007.com

PRODUCTION MANAGER: **SHELLY STEIN**
shelly@iconnect007.com

MAGAZINE LAYOUT: **RON MEOGROSSI**

AD DESIGN: **SHELLY STEIN, MIKE RADOONA,**
TOBEY MARSICOVETERE

INNOVATIVE TECHNOLOGY: **BRYSON MATTIES**

COVER: **SHELLY STEIN**

COVER IMAGE: **ADOBE STOCK © OLLY**

SMT007
MAGAZINE

SMT007 MAGAZINE®

is published by BR Publishing, Inc.,
942 Windemere Dr. NW, Salem, OR 97304

© 2018 BR Publishing, Inc. does not assume and hereby disclaims any liability to any person for loss or damage caused by errors or omissions in the material contained within this publication, regardless of whether such errors or omissions are caused accidentally, from negligence or any other cause.

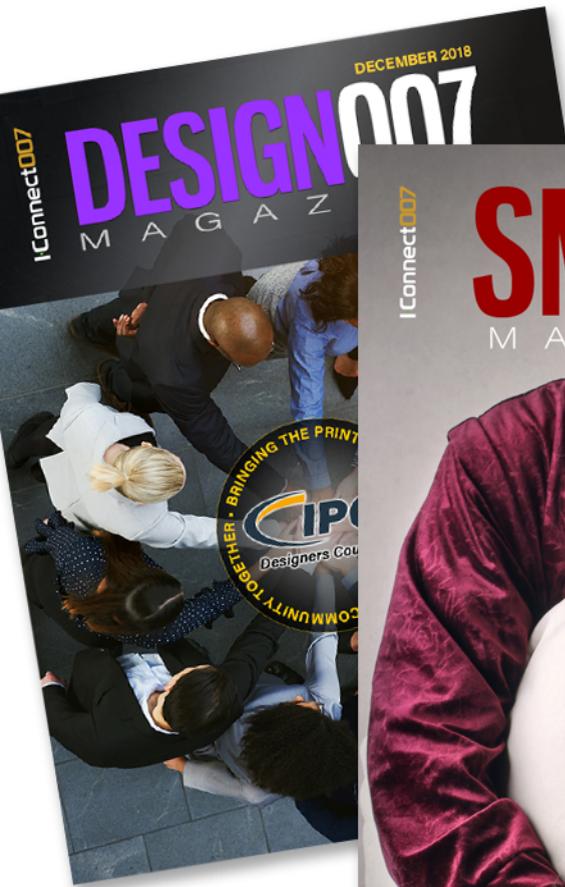
January 2019, Volume 34, Number 1
SMT007 MAGAZINE is published monthly,
by BR Publishing, Inc.

ADVERTISER INDEX

Accutrace.....	53
American Standard Circuits.....	31
APCT.....	25
Blackfox Training Institute.....	7
Candor Industries.....	79
Comet Group.....	73
Creative Electron.....	49
Eagle Electronics.....	17
Electrolube.....	89
EPTAC.....	35
FLEX007 Magazine.....	67
General Circuits.....	91
I-Connect007.....	61
I-Connect007 eBooks.....	2, 3, 99
Imagineering.....	75
Indium.....	45
IPC.....	63, 97
Koh Young.....	9
Kyzen.....	65
LPKF.....	13
Manncorp.....	5
Mentor, a Siemens Business.....	95
Miraco Inc.....	39
P Kay Metal	59
PCB007 China Magazine.....	93
Prototron Circuits.....	87
SAKI.....	21
SMTA.....	29, 69
Sunstone Circuits.....	71
SuperDry.....	41
Technica.....	55
US Circuit.....	11
Zentech Manufacturing.....	77

I-Connect007

GOOD FOR THE INDUSTRY



FREE SUBSCRIPTION



myconnect007.com

EDITORIAL CONTACT

Nolan Johnson
nolan@iconnect007.com
+1 503 597-8037 GMT-7



mediakit.iconnect007.com

SALES CONTACT

Barb Hockaday
barb@iconnect007.com
+1 916 365-1727 GMT-7



www.iconnect007.com