March 2018

SMT007 MAGAZINE

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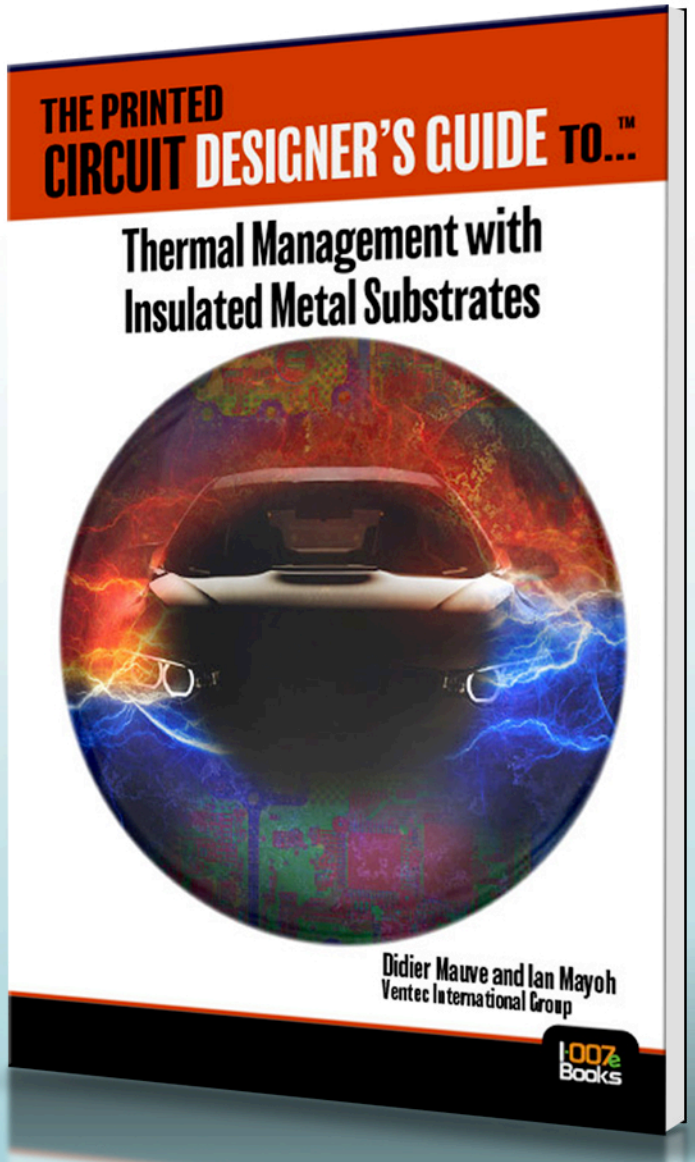

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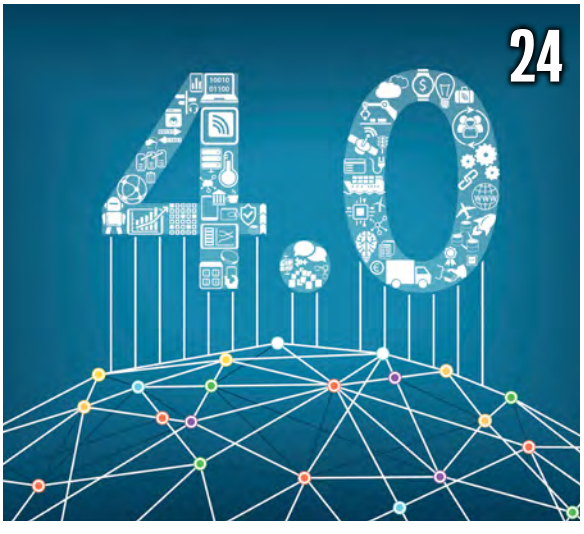

PCBA 4.0

In this month's issue of *SMT007*, we examine how Industry 4.0 trends and the increasing power of data impact the PCB assembly industry. How will these two elements take assembly processes to the next level? Our experts weigh in.

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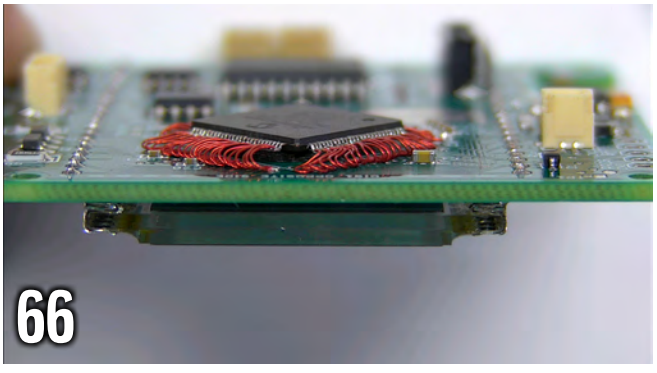

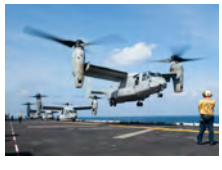

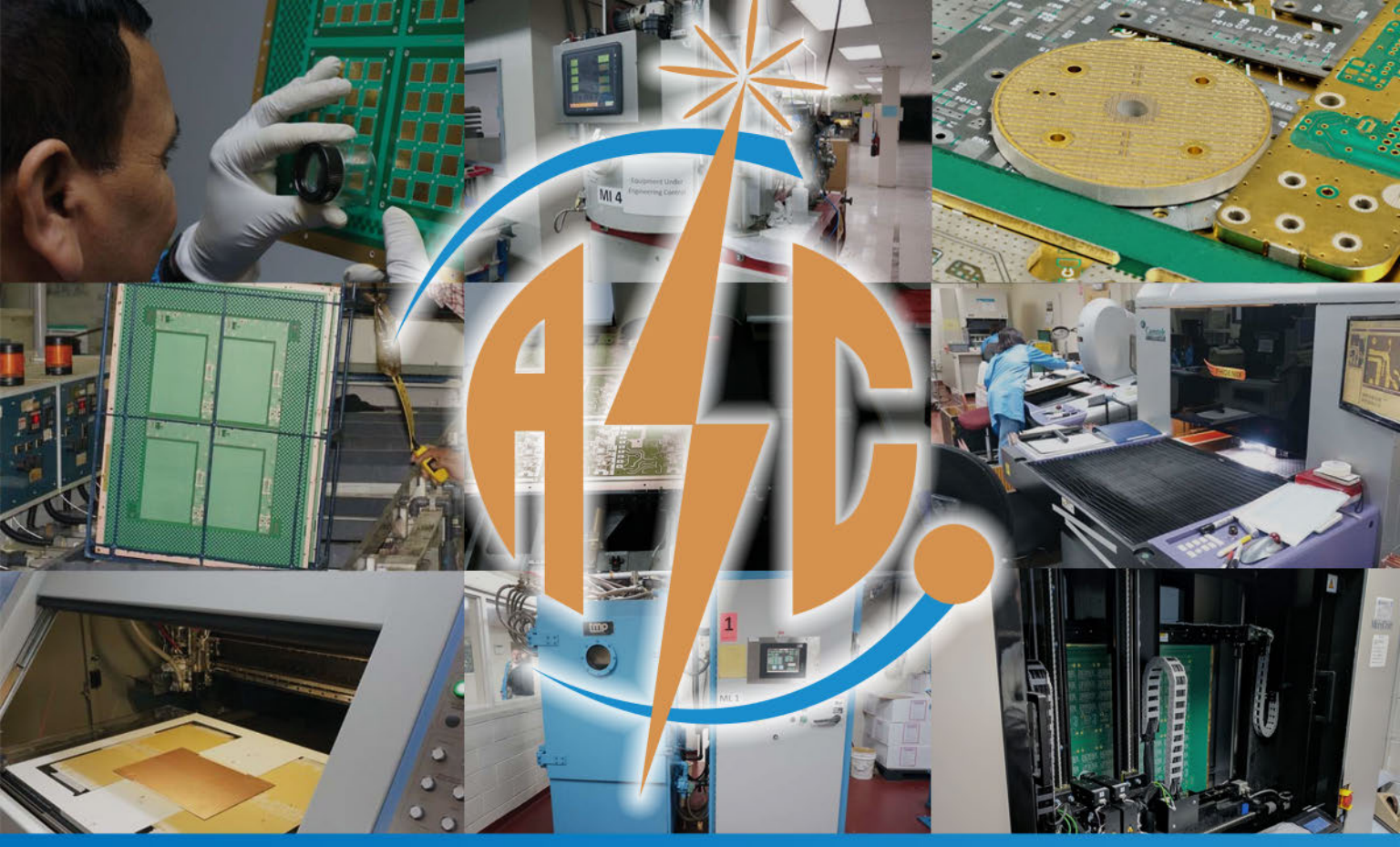

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Electronics Manufacturing (R)evolution

Editor's Note

by Stephen Las Marias, I-CONNECT007

For sure, 2018 is going to be the year of Industry 4.0, where we will see how enabling technologies including sensors, big data, analytics, and the Internet of Things (IoT), will transform the electronics manufacturing landscape.

But what's driving the electronics assembly community in this direction? The continuing rising costs, OEM price pressures, ever shorter product lifecycles, and continuously changing customer demands are clearly contributing. On top of that is the continuing evolution in electronics design and increasing integration and complexity initiated by expanding functionalities being packed in more and more compact devices and systems. These have been the key challenges of the last decade, that are, in turn, being addressed by the continuing manufacturing technology and equipment developments and advances.

But this time is different. I would say it's sort of the culmination of the underlying development that has been happening all along, but hasn't really reached the fore due to varying and differing interests and viewpoints of most stakeholders in the industry. Everyone, finally, has come to the same page, towards a new chapter in the evolution of electronics manufacturing.

The pieces—equipment, systems, and software—have been present here all along. What has been lacking is a communications standard that would enable the legacy and the more advanced smarter systems to talk to each other regardless of their vendors or their place in the electronics assembly line (be it in paste printing, inspection, pick and place, or reflow or wave).

CFX Demo at IPC APEX EXPO 2018

For the first time in the industry, a common machine communications standard for the electronics assembly supply chain—manufacturers, equipment suppliers, and solutions providers—is a reality.

At the recent IPC APEX EXPO in San Diego, California, the Connected Factory Exchange (CFX) standard was showcased, supported by more than 25 vendors who, in the words of Aegis Software's Michael Ford, "have stepped up to create the world's first conversion of a show-floor into a digital factory shop-floor."

According to Ford, this is the industry's induction to what the difference is with a true Industrial IoT standard. "Rather than being constrained by legacy data formats and content that machine engineering teams created many

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years ago, which were all OK in their day—before the modern digital needs of customers was conceived, IoT data is now available that can support the most ambitious of Industry 4.0 projects," he says. Aegis Software built the CFX toolkit that was fully donated to the IPC and the industry without cost or license.

In my recent interview with Nancy Jaster, the manager of design process at IPC, she said that she hopes to be able to demonstrate at the IPC APEX EXPO show floor how simple and easy it is to use the CFX messaging library and the transport mechanism AMQP 1.0—the building blocks of the CFX—to run the machines. She also hopes to be able to release the CFX standard this year.

In this Industry 4.0 vision, we are entering an era where we see new technologies transforming the look, systems and processes of what we consider as a modern factory. This CFX demonstration at IPC APEX EXPO 2018 is just that—imagine having these vendors integrated together towards one common manufacturing goal. A true industry evolution.

Factory in a Box

Another interesting piece of news that came out recently was the "Factory in a Box" concept created by a group of 12 electronics industry players, led by Nokia, showing how electronics manufacturers can stay ahead of the demands of Industry 4.0 through agile production.

The concept aimed to build a single electronics manufacturing line using cargo containers that can be moved to locations as demand dictates. The concept will be enabled by Industry 4.0, including cloud-based solutions, robotics and new electronic manufacturing IoT solutions. The project took a step forward late last year at Nokia's Digital Creativity Lab opening in Munich, where a cargo container with a collaborative robot assembly station was packed, moved to a new location by truck, then restarted within hours at the new location where small Lego cars were assembled, proving the precision of the machines.

The final step in the proof of concept was achieved on February 9, 2018, when full electronic manufacturing of a printed circuit board and robotic assembly and testing took place.

The group includes Nokia (wireless communication for the solution, as well as experience in deploying Industry 4.0 solutions in its own operations), Beta Layout (PCB support), DHL (logistics/transportation), Fuji (SMT manufacturing technology), HARTING (RFID solution for tracking, tracing and production control), Isel (workstation support), Isoloc (motion softening solution), MTEK Consulting (robotics), Mycronic (high-speed jet printing and jet dispensing), Rehm Thermal Systems (PCB soldering), Viscom (optical inspection), and 42Q (cloud-based manufacturing execution system). They plan to demonstrate this full capability at the Hanover Messe in April 2018.

This Month's Issue

This month's lineup of articles in *SMT007 Magazine* features some of the new technologies that would enable the transformation of the processes in the electronics assembly industry. From cleaning to software to stencil design and cloud computing, these elements are key components that will surely help take the electronics assembly process to the next level, one process at a time.

Next month, we'll look at what's driving the automotive electronics industry. Stay tuned! **SMT007**

Stephen Las Marias is managing editor of *SMT007 Magazine*. He has been a technology editor for more than 14 years covering electronics, components, and industrial automation systems.

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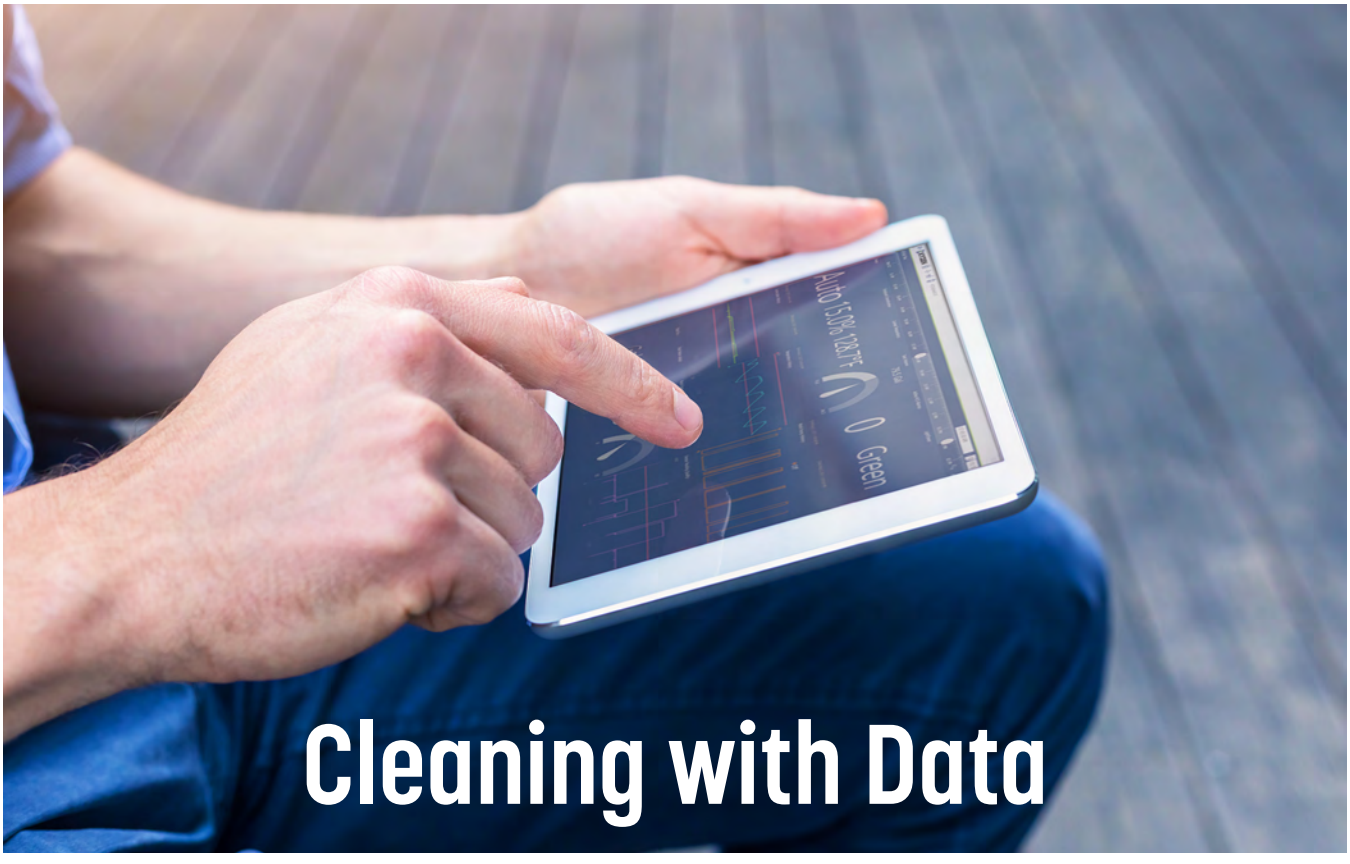

Cleaning with Data

Feature Interview by Barry Matties
I-CONNECT007

During productronica, Tom Forsythe, vice president of KYZEN, spoke to Barry Matties about KYZEN's new process control monitoring and data service. They discussed the drivers behind these developments, the company's focus on managing data, and how KYZEN plans to support an industry embracing more cleaning and Industry 4.0.

Barry Matties: Tom, please tell me about this impressive new technology that you're showing us.

Tom Forsythe: Absolutely. The beginning part, of course, is process control. We've been selling process control units for 20-something years. Over the last three or four years we've said, "All right, we've got these systems, and they're super robust, very reliable, and very popular, but they're boring. They're kind of in the corner, they're doing their thing, but they're not really engaging the customer very much."

We looked into it, and we realized that we were collecting, monitoring, and triggering off loads of data, some of which we saved and some of which we didn't. We thought, "All right. Let's review this data experience." We can collect all this data. We figured out how to blow it up to the cloud in a very attractive, user-defined data visualization sort of mode, and then we started going through the ticks and tacks of it all. What are we actually checking? And, how do we collect this data?

There are either 40 or 50 different data streams, things like the amount of fluid that's left in the drum, etc., so you don't have to kick it to see if it's empty. You can set parameters for any of these variables and get an email or a text alert to tell you that something has hit a warning zone or a stop zone. You don't have to pay attention, and of course the data is delivered via the cloud, which makes it platform-agnostic; you can see it on your phone, your iPad, and your PC.

So you have immediate access to that data for in-the-moment operational troubleshooting, or just process review. One of the other value-

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adders that we've gotten back from customers is, "Oh, this is tremendously helpful. That's all great because we want our system to run well. But what's even better is when they say, "I got a board back that we made six months ago, and I need to do this audit to prove to the customer that we didn't do anything wrong. Now I've got this tremendous trove of cleaning data that says it is OK to move on to some other part of the process, or there is something wrong with the board." We weren't really thinking about that when we put it together; we were more in operational mode. But it's there, and the software can show the time window and zoom in so you can root around anywhere in the data set for a look back later.

Matties: Is the data service a subscription program? How does that work?

Forsythe: Well, both. At this point, it is a subscription that is included in the package, but we do see this as a subscription having a life of its own down the road. And there are lots of possibilities which are going to be evolving over the course of the next year.

Matties: Let's back up and just talk a little bit about KYZEN and what you do, and then we'll connect the dots.

Forsythe: We're in the cleaning materials business. Our business is developing products that will remove flux residues without harming the parts, for material compatibility, label compatibility, all that sort of stuff. No-clean was invented 25 years ago. Well, we can all agree that we probably want residues inside our pacemaker cleaned or removed, whether it's put together with no-clean paste or not. Likewise, we can likely agree that the residues inside a child's toy are safe to stay there.

And somewhere between those two clear in-points is where decisions get made, yea or nay, regarding whether cleaning is a value-adder or not. As the world of miniaturizations continues to grow, and devices continue to shrink, employing bottom termination components that are growing in popularity and creating cleaning challenges, the general consensus of where that line between clean and no-clean is moving, drifting gently in the direction of more cleaning, rather than less cleaning. And cleaning is what we do.

We evaluate popular soldering materials from 10 or 20 soldering companies. We have a database with decades of data, which we share the data with the individual solder materials company alone, so they get that feedback for future development purposes. In fact, some companies choose to put us in their product development cycle where we'll get several experimental formulas, and that's simply another data point for them to use as they make their final down selects. Sometimes, even we are surprised that we had an early look at a new product. We have all been to a show like this, and someone's introducing a new paste, saying, "Oh, we need to get some of this new product to test," and they say, "No, remember that XYZ product from last year?" "Yes, that's this one that we had tested months and months before." That's a common part of our business. We provide materials to get that cleaning done, not the hardware. We don't make cleaning machines.

Matties: But now you're in the data business.

Forsythe: Well, we've been in the control business for many years because it needed doing. The cleaning machine companies didn't really see that as in their lane because it was a process control game, rather than a process set point, which is more what the machines are about.

Matties: Right. Here's the temperature.

Forsythe: Exactly, and that's what they're doing, and they're doing a great job. So, we've always

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been in the process control end of the pool, and it's just in these last couple of years where we've realized that under the roof of process control, we're touching loads and loads of data. If we can develop a delivery system, and then record it, it's a value-adder for our customers. This evolution has gone on over the last 36 months, or so.

Matties: Well, what you're creating, though, is software that presumably could work for any solution, right?

Forsythe: Right, fundamentally there's a sensor in the system that's doing the right sensing, the concentration measurements. The latest systems we have introduced are pretty much product-agnostic, though, while there are certain technologies that won't work, most of the technologies from most of the people in the market will successfully measure the concentration.

So, whether that will be true across the board or not is unknown at this point, but with the latest sensor technology, it is known. Yes, we might be willing to do that for this sort of stuff as well, because we think this data delivery system is something that customers need and want, and the tooling that we've put in place to capture that data and relay it is, we think, a raw winner for our customers.

Matties: Are you programming all your software in-house?

Forsythe: We're doing it in-house in Nashville, Tennessee, where our headquarters and R&D center is.

Matties: So it's all under your control. That's makes a big difference, doesn't it?

Forsythe: Well, in the beginning it's hard. But once you figure things out and move forward, it also allows you to be very hands-on. Our approach to things is to try to understand the inner workings of hidden mechanisms, because that allows you to advance the technology at a rapid rate. How do you get to the next generation if you don't really know what the other one did? So, we are believers and investors in bringing this sort of product development in-house for our customers' mission-critical needs. If they have a mission-critical problem, rest assured that we also have a mission-critical problem, and we both win if we can help solve it quickly with robust, reliable control systems and rich data sets.

Matties: And it was a wide open gap.

Forsythe: Yes, and while there are others that do it a bit, we tend to be the ones who do it the most.

Matties: Now you have this great tool; people can access data, and it looks at a lot of different points of data that they can extract. You're only creating a new business here.

Forsythe: Well, it's certainly a piece of our puzzle, and we looked at it from several perspectives even just in our cleaning space. There's operational cleaning where people are cleaning their assemblies. There's stencil cleaning, and there's maintenance cleaning. Those are all cleaning, but they're different. If I'm not worried about the part, maybe I'm cleaning an oven. Well, there's a different standard, there's a different value add for the customers made perhaps a bit less. So, while they're similar businesses, they're different because the drivers are different. This is just another one of those that's essential to cleaning. We're staying very focused on the cleaning zone.

Matties: But what happens is that that data now needs to integrate into their company-wide

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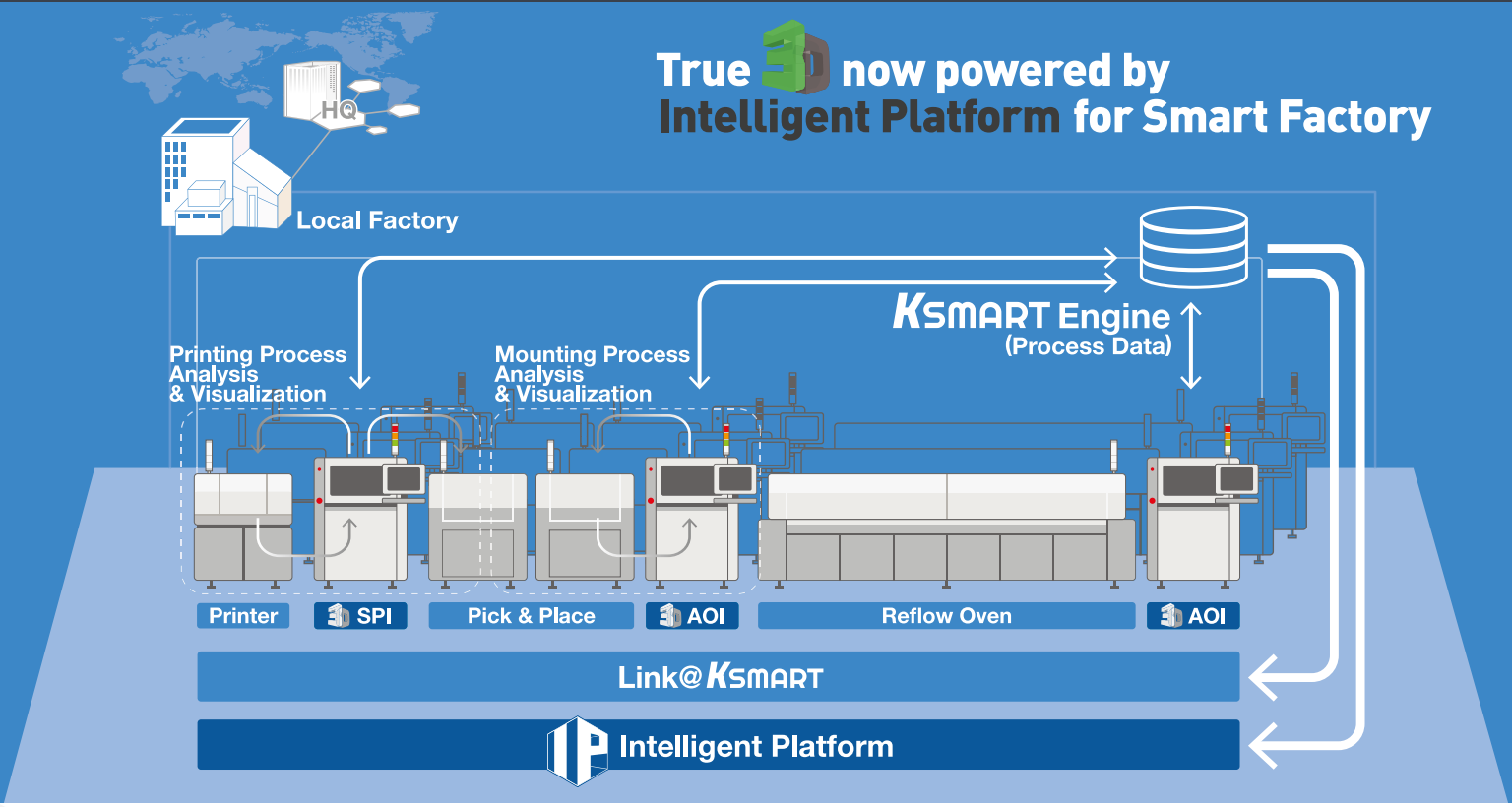

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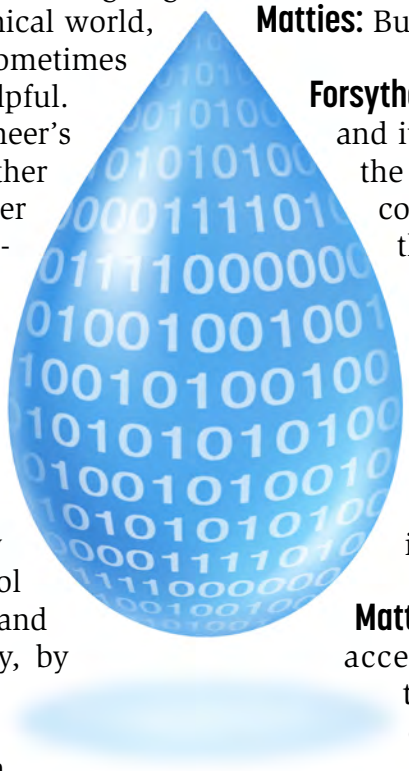
data stream. And the demands are going to be there for that.

Forsythe: We suspect so, yes. That's a natural progression, where we'll be the guy feeding that cleaning data, the pick-and-place guys are going to be feeding in their data—the AOI and SPI, every process in the line. We'll simply be leading the way on the cleaning side.

Matties: What sort of feedback are you getting from the customers?

Forsythe: They're quite satisfied, because it's a delivery system that is providing user-friendly alerts, and no one needs another horn going off in the factory. And it's a technical world, so even the flashing lights are sometimes more distracting than they are helpful.

So, the idea that some engineer's getting an alert on his phone, whether it's a text or an email, whatever their choice maybe, is empowering. They're up at their desk, say they're at the end of the building, and they get this alert. Well, instead of running to that machine to find out what's going on, they log onto the system, click, look and see if corrective action is needed, and if so, by whom. This is a very real-time tool that we think adds a lot of value and a lot of performance to their day, by simplifying their day a little bit.



Matties: Right, and aside from those efficiencies, are there other efficiencies that they found in just processing alone, or in some points that they didn't even realize?

Forsythe: Sure, and remember this: Engineers are thinkers. Our customers are thinkers. They're going to look at this data and they're going to connect some dots in their world and say, "You know, we have this little issue over here on the side; I wonder if I tweak this just a little bit, maybe that will solve some other problems." And by having that well-controlled system and the data, it allows them to experiment and try to improve their overall process by making some tweaks to the cleaning process.

Matties: How does that affect their security?

Forsythe: We've taken two steps to ameliorate that issue. First, this is a transmit-only system. There's no remote-control change settings capability at all; it's simply a broadcast-out, so that should decrease the opportunity for someone to hack in since there's no ramp or in-channel. Secondly, we separate the bar code data from the backup data in a customer's product; it doesn't go to the cloud, so that stuff stays local.

Matties: But it's still traceable?

Forsythe: Still traceable, but it stays local, and it doesn't go to the cloud. So now the data that's out in the cloud is not connected to anything. It separates the process data from the product, and the process data by itself doesn't help anybody because most people want many part numbers. The idea that someone outside your organization could know what part number is being run in any particular time is pretty hard to get to.

Matties: You've covered security and accessibility; it's all Internet-based through the cloud. What about customization?

Forsythe: Well, there are the displays, whether line graphs or the dashboard tiles, and they can all be tweaked and twisted, and you can make one bigger and one smaller. The software might decide it should be aligned, but if you like a bar chart, so there are loads of choices in there to play with, to have it speak in the clearest possible way to the individual user.

Matties: In terms of the customization and utilizing it in the factory, is it only tied to your controllers?

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Forsythe: Right now, this is tied to our controllers. Down the road, who knows? But right now, we're making the cleaning process better. That's our job. If we make the cleaning process better, then we're delivering the maximum value as the cleaning guy to our customer, which, chances are, is a good thing for us.

Matties: Is there anything that we didn't talk about regarding this that we should be covering for our readers?

Forsythe: No, I don't think so. In the cleaning space, KYZEN is the first with this whole data visualization approach to getting all the data in your system, putting it at your fingertips, and making it easy to use and access anytime. I'm sure in others' spaces, there's lots of data floating around from all of the inspection systems, so in the different silos or the different stations along the assembly line, there are lots of people looking at their acre of diamonds and saying, "How do we provide information that will feed into the overall control system in the sky, which today is still more conceptual than deliverable?"

Matties: I think the challenge there is the language standard, right?

Forsythe: Absolutely. We'll just stay close to the standards and see how they turn out. Cleaning doesn't usually drive the boat on things like that, so we simply try to be well informed and adapt as appropriate.

Matties: Well, Tom, thank you so much. This has been great.

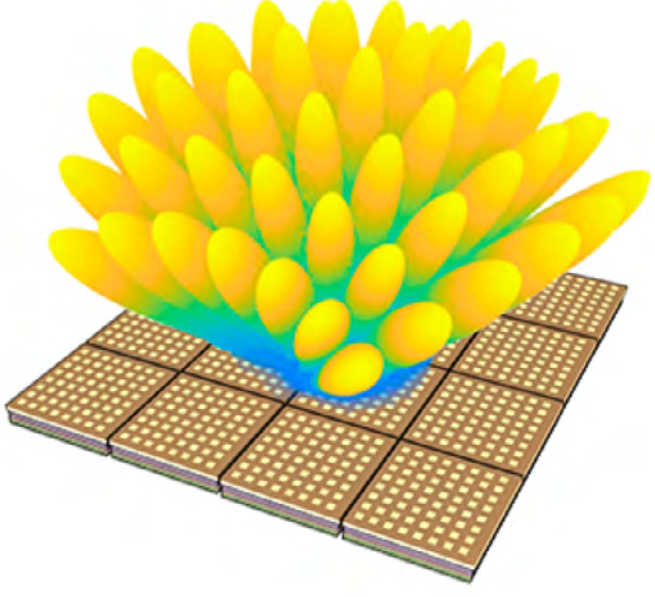
Forsythe: Thank you. **SMT007**

Improving Military Communications with Digital Phased-Arrays at Millimeter Wave

DARPA is launching the Millimeter-Wave Digital Arrays (MIDAS) program to develop element-level digital phased-array technology that will enable next generation DoD millimeter wave systems. To help solve the adaptive beamforming problem and ensure wide application of the resulting solutions, MIDAS seeks to create a common digital array tile that will enable multi-beam directional communications. Research efforts will focus on reducing the size and power of digital millimeter wave transceivers, enabling phased-array technology for mobile platforms and elevating mobile communications to the less crowded millimeter wave frequencies.

Advances in element-level digital beamforming in phased-array designs is enabling new multi-beam communications schemes to help significantly reduce node discovery time and improve network throughput. To reduce the size of the arrays, advances in millimeter wave technology will help push the frequency of operation to higher bands, bringing the capabilities of directional antennas to small mobile platforms.

To accomplish its goals, MIDAS is focused on two key technical areas. The first is the development of the silicon chips to form the core transceiver for the array tile. The second area is focused on the development of wide-band antennas, transmit/receive (T/R) components, and the overall integration of the system that will enable the technology to be used across multiple applications, including line-of-sight communications between tactical platforms as well as current and emerging satellite communications.



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Plexus Releases Fiscal Q1 2018 Financial Results ▶

Plexus has achieved record revenue of $677 million in its fiscal first quarter of 2018.

Celestica to Acquire Atrenne Integrated Solutions ▶

Celestica Inc. announced that it has entered into a definitive agreement to acquire Atrenne Integrated Solutions Inc.

Sanmina Reports Preliminary Q1 FY2018 Results ▶

Sanmina Corp. has announced preliminary financial results for the first quarter ended December 30, 2017 and the outlook for the second quarter ending March 31, 2018.

Libra Industries' Dallas Facility Recertified to AS9100 Rev D ▶

Libra Industries' Dallas, Texas facility has successfully completed its recertification for the AS9100 Rev D SAE International Aerospace Standard.

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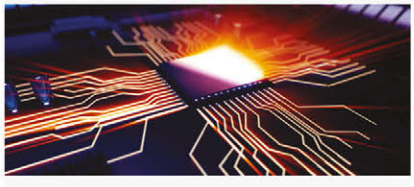

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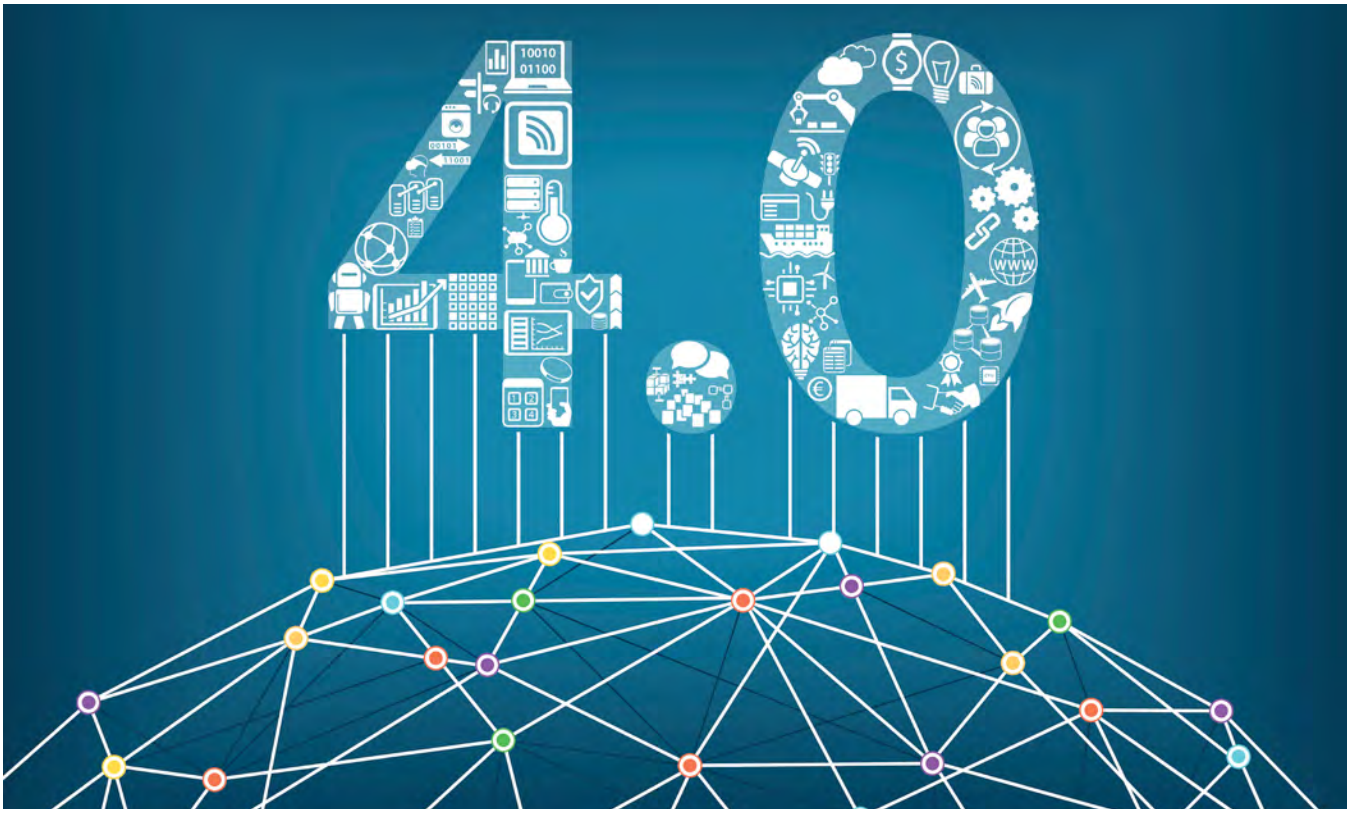

Industry 4.0 Technologies: If Only I Had Known

Feature Article by Michael Ford
AEGIS SOFTWARE

The introduction of a fundamental new technology in 2018 is poised to be the catalyst for the now long-awaited Industry 4.0 revolution. What is coming is not a single master Industry 4.0 solution as people may expect, but rather the opportunity for everyone in the industry to play their part, re-evaluating what can be done in their processes or products to take maximum advantage of the new CFX-fueled Industrial IoT environment. It's time for everyone to get a serious heads-up.

If Industrial IoT were a transport infrastructure, we would look back on this time as when trails and dirt-tracks were replaced with paved roads and highways, enabling the development and evolutions of high-performance automobiles. Not everyone today buys or drives the same car. There is no single perfect model or configuration for all, but the one thing that we can rely on, is that all our cars work and co-exist on the same road network. This is the principle also for IoT solutions, though in the CFX world, there are no toll roads, no competing commercial options that we would have to pay subscriptions and have to select what road network vendor we wish to use.

No matter what the intent, scale budget or capability, many individual IoT solutions are going to be developed to support specific business needs, which will run through the same IoT infrastructure. As we have seen with automobiles replacing horses and carts, the expectations are changed, for example in terms of distances that can be covered, the time taken for journeys and the amount of baggage or freight that can be carried. With the CFX Industrial IoT solution, we are not simply seeing a horse that can run a little faster, or a cart with a couple more wheels, this is a real revolution and a fundamental change to what can be achieved.

The IPC Connected Factory Exchange (CFX) standard specification defines all three major

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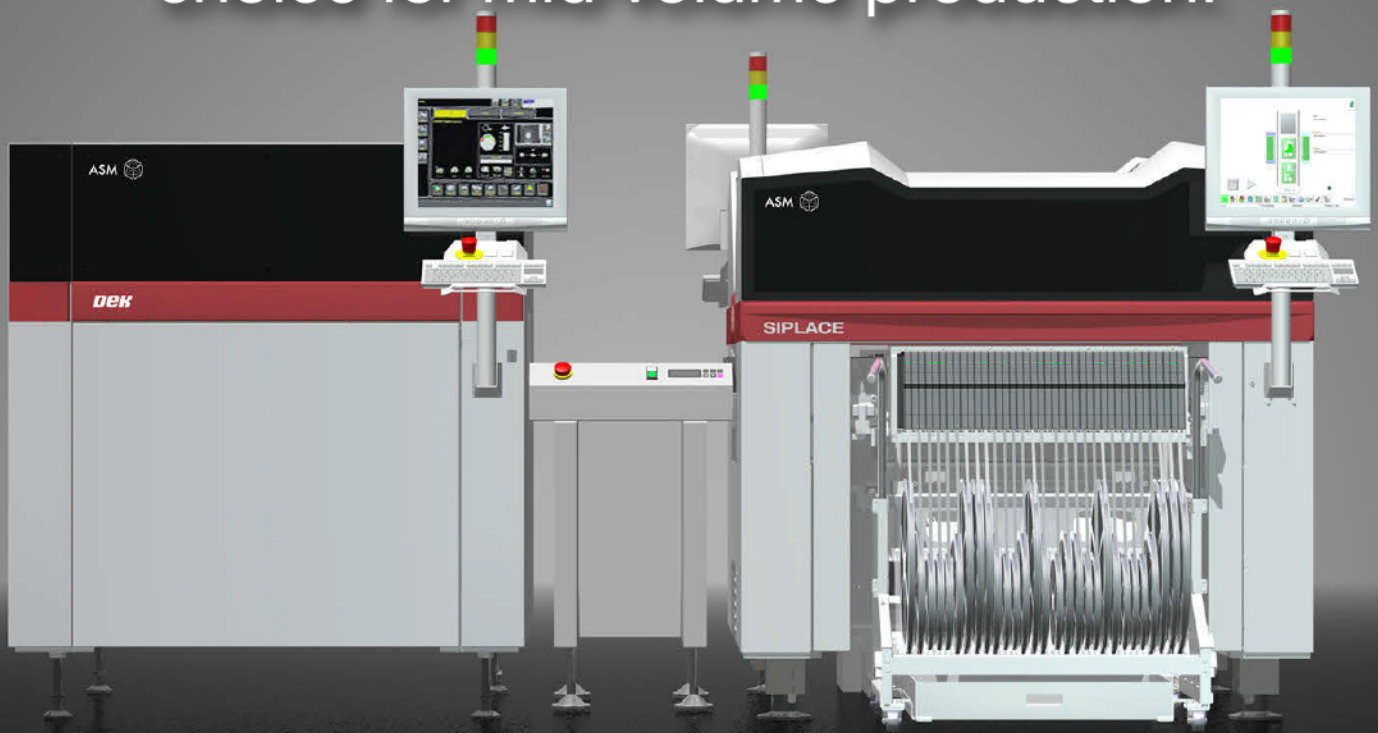

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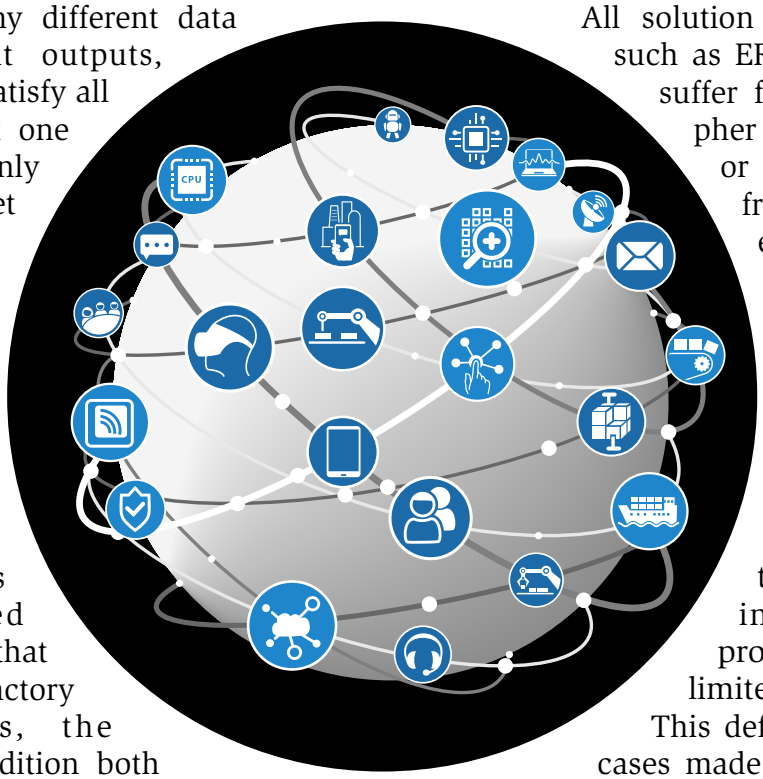
components of a "plug and play" IoT communication solution. These comprises of the protocol, which is the secure connection (AMQP v1.0), the encoding method, which is the way in which the data is represented in messages (JSON), and the message content definition. CFX is uniquely created in this way to bring genuine inter-operability across machines on the shop-floor, with no licensing or middleware required. Companies will be able to pick and choose CFX-based Industry 4.0 solutions from machine vendors, solution providers, and will even find it easy to augment solutions with in-house development.

There is something for everyone with CFX. Machine vendors will replace the need for the support of many different data customer-dependent outputs, and will be able to satisfy all customers with just one CFX interface. Not only that, vendors also get the opportunity to obtain data from all other production machines and stations, as well as factory level information through the same CFX interface. Each machine process now has an unprecedented "digital visibility" that includes changing factory work-assignments, the line status and condition both upstream and downstream, materials availability and assignment, the digital product model, resource availabilities etc. For example, instead of hearing the phrase, "if only I had known," when materials arrive with different supply forms and rotations than those expected, or the line stops for maintenance when nothing was prepared, or an unexpected change-over happens which causes extensive setups of materials and inefficient machine programs, CFX makes all of the information available to each machine, so that unprecedented levels of optimization can be achieved through the use of that performance information. Machine options will undoubtedly appear in the form of added value digital Industry 4.0 solutions for higher mix optimization, active quality management, enhanced flexibility, faster new product introduction etc. As well as commercial machines, other processes such as, bespoke functional testers, manual assembly, inspection, test operations and transactional operations, etc., are supported by CFX. In-house jig development teams would easily include interfaces into machines that they create or processes that they execute. The IPC CFX SDK makes integration of CFX possible with the minimum of development overhead.



All solution providers, in areas such as ERP, MES, MOM, etc., suffer from having to decipher data derived directly or through middleware from the many different types and vendors of machines. It is not only the complex conversions and unexpected changes in the data itself that cause problems, but the fact that legacy machine interfaces can only provide a defined and limited amount of data. This definition was in many cases made by a machine engineering team many years ago. If only they had known then what the customers would need in the future and the direction that IoT solutions would take, and if only companies had had the vision to work together. CFX resolves these content problems, bringing everyone up to a level playing field, so that factory solutions need no longer be dependent on the lowest common denominator of process capabilities across the factory. Values created and offered to customers are therefore transformed through enhanced content, accu-

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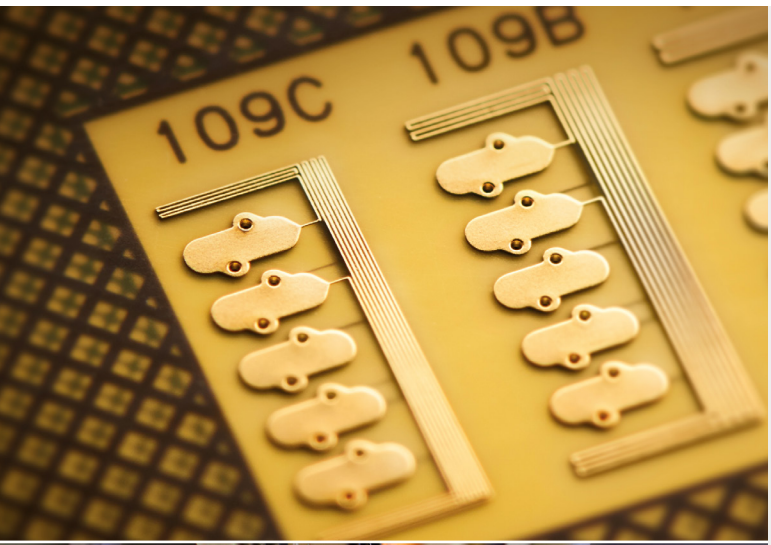

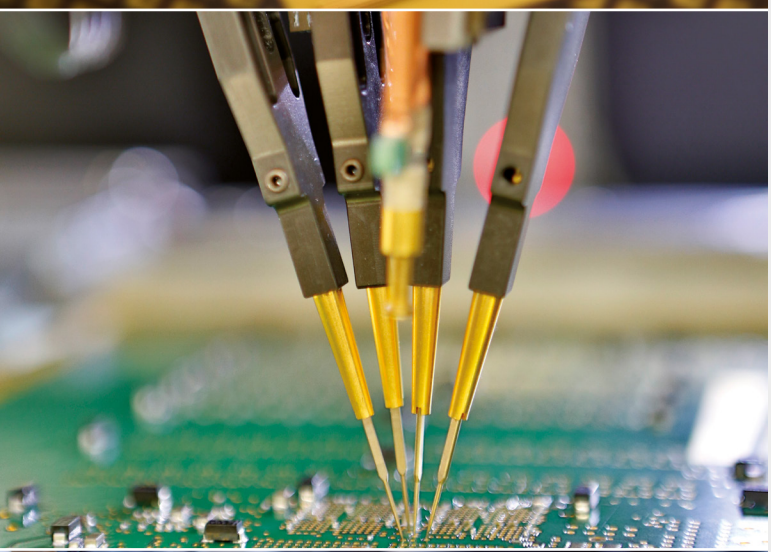

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racy, detail, and timeliness, to the extent that operational decisions can be automated or at least augmented. Work-order allocation, planning and sequencing, material control, etc., can all be enhanced by decision-making logic based on such digitalizations, with managers having a complete and accurate understanding of trends and potential effects from proposed changes, such as a request for greater quantities of a certain product.

The real winner, of course, is the manufacturing operation itself. Industry 4.0 digitalization based on CFX means that ultimately, the complete factory operation can be digitally modelled. Rather than having critical operational production management decisions taking days with many meetings and phone calls, using the digital factory model, changes and adjustments can be confidently executed in minutes or even seconds, for example, to introduce new products, adjust order or delivery quantities, with the assurance that materials will be available, where and when needed, that utilization and efficiency of machines will not suffer, and that no excess finished goods stock need be accumulated. No more excuses in management meetings with the phrase, "if only I had known." The digitalized factory based on CFX becomes a very lean, digital, high-performance manufacturing engine, that can cope with a far higher mix of products yet also provide far higher throughput and efficiency. The digital model extends further, to provide automated conformance and compliance, a complete digital traceability record, with qualified meaningful data fed to the cloud for enterprise-grade analytics for future business development.

Though we will look back to see that 2018 was the year in which digitalized Industry 4.0 factories with CFX started, the growth that follows in terms of accessible, available and uncomplicated digitalization will be remembered over many years. CFX digitalization is available to all sizes and sectors of manufacturing companies. It will be stable and dependable, as Industry 4.0 technologies based on CFX evolve into everyone's everyday tools.

While "off-roading" may continue to be enjoyable by many, unless you are a farmer, it is probably best kept as a hobby or a sport, rather than something on which your business transportation needs depend. **SMT007**

Michael Ford is the European marketing director for Aegis Software.

Olivier Pirou Discusses Mycronic's Acquisition of Vi TECHNOLOGY

Recently, at productronica, Mycronic announced the acquisition of Vi TECHNOLOGY with the intent of combining VIT's inspection technology with Mycronic's jetting capabilities. In an interview with I-Connect007, Olivier Pirou, Managing Director of VIT, discusses more about the merger and how this will help VIT contend in such a competitive environment. Other topics of discussion include the synergy between Mycronic's jet printing technology and VIT's solder paste inspection technology; how Mycronic will strengthen VIT's advantages over the other inspection systems provider; and how their cultures will fit.

Click here to read the interview.

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Supply Line Highlights

Indium's Karthik Vijay Talks Engineering for Automotive Applications ▶

Barry Matties met with Karthik Vijay, Indium Corporation's technical manager for Europe, at last year's productronica, where everything from stencils and laser cutting to flux technology and jetting were discussed. If you want to know about where material technology currently stands in the automotive landscape, you'll want to read on.

SuperDry's Novel Approach to the Drying Process ▶

Pete Starkey spent a few minutes at the SuperDry booth on the first day of the productroncica show, and chatted with old friend Rich Heimsch, who taught the old dog a few new tricks about the drying process.

Indium Earns ISO/TS 16949 Automotive Certification ▶

Indium Corporation has been awarded ISO/TS 16949 management system certificates for two of its manufacturing facilities and company headquarters.

JTAG Visualizer Update Adds Features for Faster Debug ▶

The latest version of JTAG Technologies' acclaimed Visualizer graphical viewing tool for PCB layouts and schematics allows users to assess fault coverage data and pin-point production test faults in a snap.

Distributor YouSMT Strengthens Mirtec's Presence in Italy ▶

Since partnering with Mirtec Europe in late 2017, Italian distributor YouSMT has been expanding Mirtec's reach throughout Italy with the sale of numerous systems.

Super Dry Totech Launches LTS2, Comprehensive Long-Term Storage Solutions ▶

Super Dry Totech's LTS2 Long Term Storage Solutions is designed for those companies that need to store components long term without risk of degradation, but do not wish to make the investment in capital equipment and are looking for a flexible and scaleable off-site warehousing solution.

SMTA Capital Chapter to Host Chapter Tutorial Program ▶

The SMTA Capital Chapter will host a Chapter Tutorial Program on March 15, from 9 a.m. to 3 p.m., in Rockville, Maryland.

Juki Names Greg Lefebvre Regional Sales Manager for the Americas ▶

Juki Automation Systems (JAS) Inc., a provider of automated assembly products and systems and part of Juki Automation Systems Corp., has appointed Greg Lefebvre as regional sales manager for the Americas.

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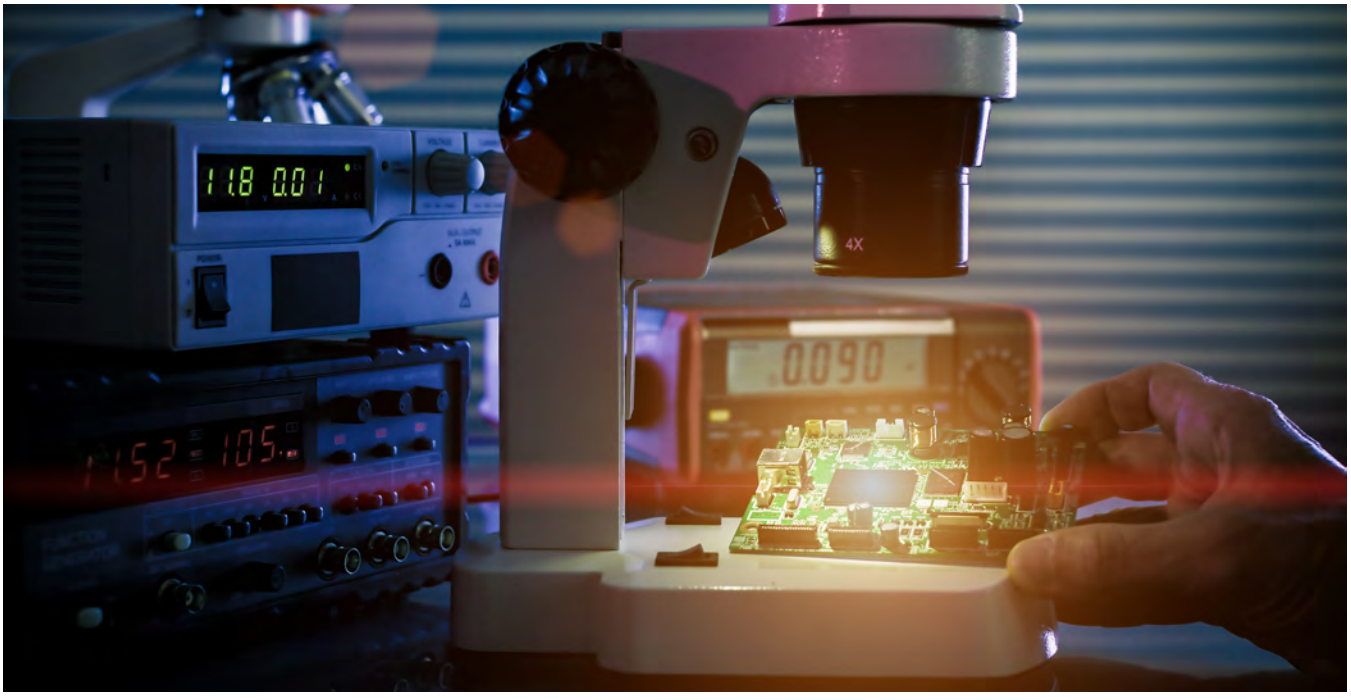


Stencil Printing Techniques
for Challenging Heterogeneous Assembly Applications

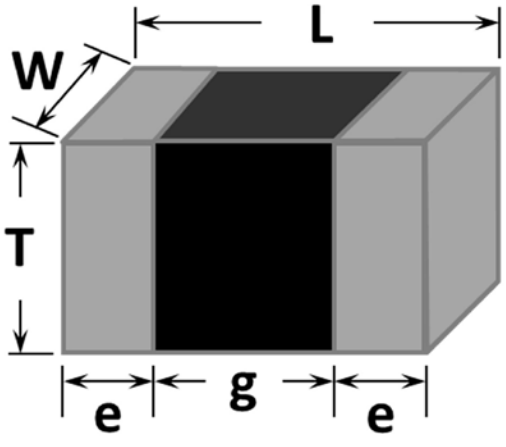
Article by Mark Whitmore and Jeff Schake
ASM ASSEMBLY SYSTEMS

A new generation of near microscopic size SMT chip capacitors has appeared in the market, known as either 0201 (metric dimension label) or 008004 (imperial dimension label). Assembly results using these components is so far largely obscured from publication and highly proprietary. All aspects of the assembly process are expected to be challenged to accommodate the extreme level of miniaturization embodied in this device. The objective of this research is to investigate and characterize the stencil printing process for compatibility with M0201 (metric 0201) capacitor assembly. Effects of circuit board quality, stencil thickness, and stencil nano-coating are the primary experiment variables reported against solder paste volume transfer efficiency and raw-volume print distribution.

M0201

The designation M0201 implies a case size length of 0.2mm and width of 0.1mm, when in fact these are produced at nominal dimensions of 0.25mm x 0.125mm (Figure 1).

In a footprint-area comparison, the M0201 covers only 39% of a M0402 (imperial 01005) chip component. M0201 capacitors were first commercially available for volume prototype



Murata GRM Series (all dimensions in microns)

L	W	T	e	g
250	125	125	50 - 100	50
@ ± 13	@ ± 13	@ ± 13		@ min.

Figure 1: M0201 capacitor dimensions and tolerances [2].

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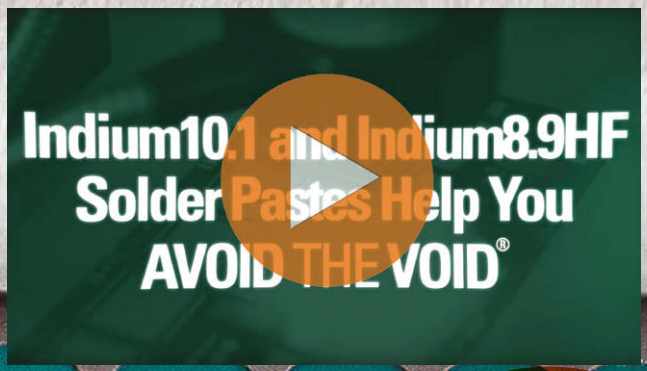

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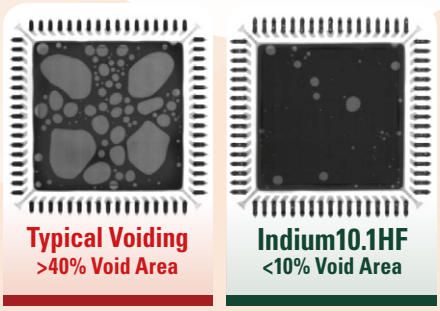

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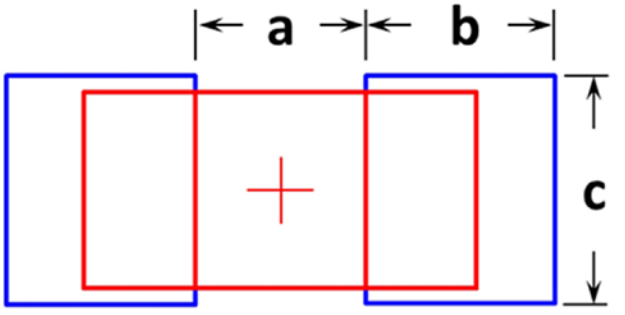

Murata GRM Series (all dimensions in microns)

L/W Code	Chip L x W	a	b	c
01	250 x 125	100 - 110	70 - 120	125 - 145

Figure 2: M0201 vendor pad size recommendations[4].

D = Side Joint Length = 70µm
H = Termination Height = 125µm
F♣ = Min. Fillet Height = G + (25% H) = 46µm
G♦ = Solder Thickness = 15µm
L = Pad Length = 120µm
P = Pad Width = 145µm
U = Side Joint Width = 10µm
V = Solder Joint Volume
W = Termination Width = 125µm
Y♠ = End Joint Width = 26.7µm

♣ IPC-A-601E, 8.3.2
♦ Based on cross sectioned examples
♠ Author specified

Table 1: Label definitions for Figure 4.

assembly testing in 2014[3]. Resistor M0201 passives are not yet known to be offered.

PCB land design options for M0201 are shown in Figure 2 as prescribed by the component manufacturer. The smallest pad size is 125µm x 70µm, which approximately matches the metal end terminal footprint. The largest pad size nearly doubles the smallest pad size area at 145µm x 120µm.

The pad design of our preference is shown in Figure 3, which is at the top limit of the suggested pad size range. The motivation for using such sizeable pad dimensions include:

Over-etched Cu is expected to be problematic at this dimensional scale. Using the largest Cu pad design should at least help to improve PCB manufacturability.

Typically, the stencil aperture size mimics pad the dimensions. The largest pad area offers to ease aperture area ratios and permits potentially improved print volume control.

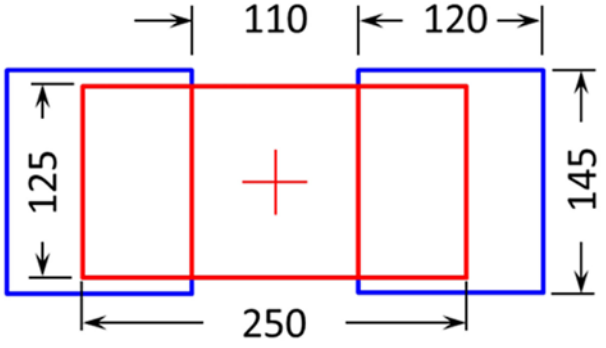

Figure 3: Selected M0201 pad design for drint study.

Prerequisite Solder Volume

The determination of a suitable stencil aperture capacity requires prerequisite knowledge of the appropriate reflowed solder joint form. The IPC-A-601E standard was consulted as an appropriate reference to determine this [5]. Figure 4 illustrates the model used to establish the structure of an acceptable M0201 solder joint of minimum volume. See associated Table 1 for legend. Author judgment prevailed for dimensions not explicitly provided in the 601E standard. The determination of this smallest

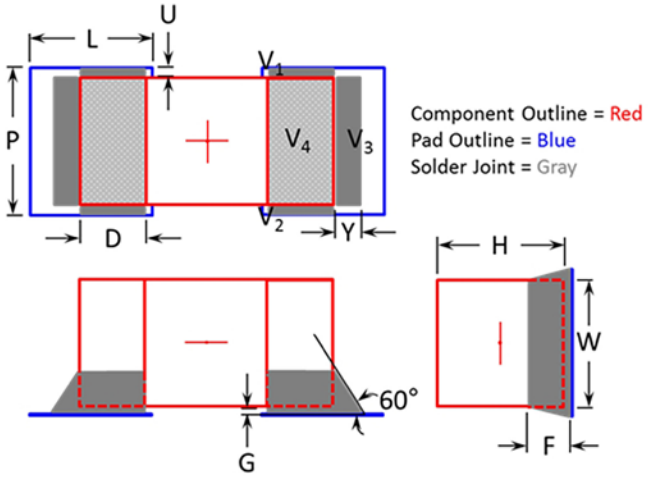

Figure 4: Minimum solder volume termination model.

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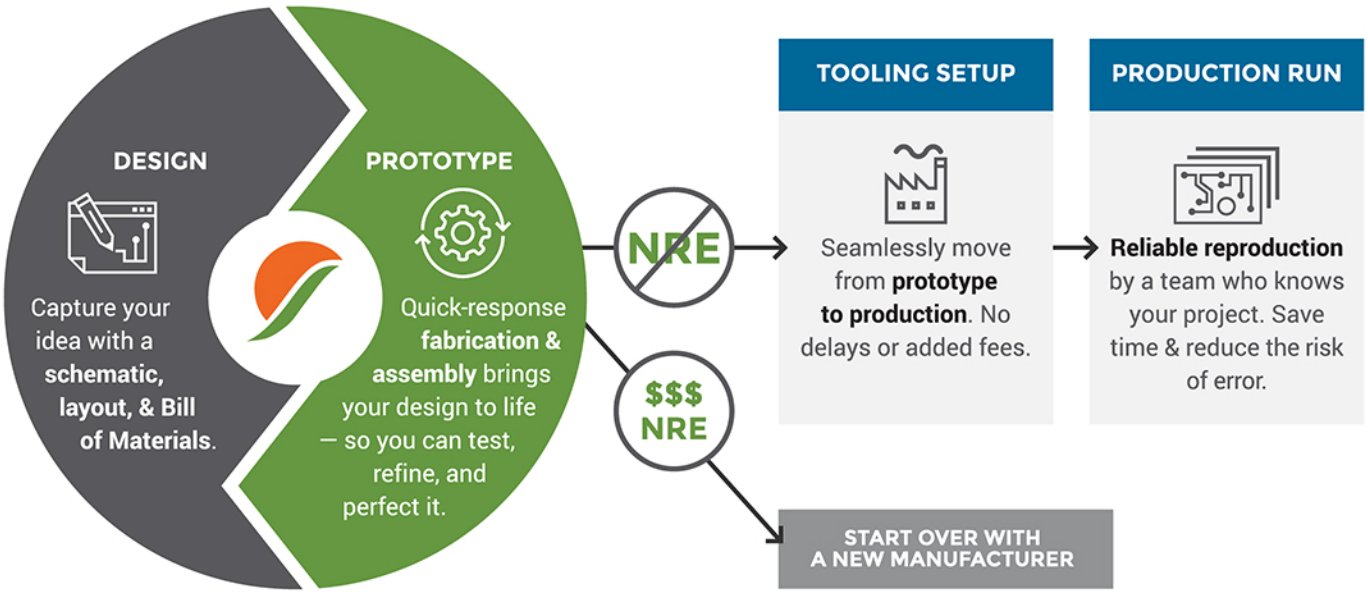

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	Solid Vol. (S) / Paste Vol. (2S)
$V_1 + V_2 = D \times F \times U =$	32200µm³ / 64400µm³
$V_3 = 0.5 \times F \times W \times Y =$	76763µm³ / 153526µm³
$V_4 = D \times G \times W =$	131250µm³ / 262500µm³
$V_{Total} = V_1 + V_2 + V_3 + V_4 =$	240213µm³ / 480426µm³
	~ 0.48 nanoliter

Table 2: Minimum termination solder volume result.

solder volume is helpful in establishing a stencil design and for evaluating print performance against solder paste inspection (SPI) data.

The geometry of the soldered terminations with minimum solder volume have been simplified as triangles at the sides (V1, V2) and end of the terminal contact (V3) while the largest volume contributor to the solder joint is the rectangular area underneath it (V4). The solder thickness dimension G contributes substantially to the overall solder joint volume. As the objective here is to determine a minimum solder volume, our interpretation of the 601E standard does not require the pad to be fully wetted to form an acceptable solder joint shape. The quantitative breakdown of this solder joint model is provided in Table 2. An acceptable ratio of solder paste to metal by volume is 2:1[6]. From this it is found that each chip component termination should require at least 0.48 nanoliters (1nl = 1,000,000µm³) of printed solder paste volume to form an acceptable reflowed solder joint. Note this amount scales to the pad dimensions selected (i.e., smaller pads will not require as much solder paste to comply).

The printing stencil must be designed with aperture opening dimensions that will allow solder paste transfer accomplishing at least 0.48nl per pad. The difficulty in achieving this relates to practical restrictions on stencil thickness. For the products likely to see earliest implementation of M0201s, common stencil thickness used today is 100µm. The inclusion of M0201 will compel the use of even thinner stencil foils to reduce the risk of producing insufficient volume paste deposits attributed to clogged apertures. It is well documented that print transfer efficiency (TE) of solder paste scales proportionally to stencil aperture area ratio [7]. Area ratio (AR) is defined as the aperture opening area divided by the aperture wall area.

AR values reducing further away from 0.6 will escalate average paste transfer loss while also increasing scatter in printed deposit size and shape. This principle is described in Figure 5 where the thicker stencil is less capable to transfer its full capacity of solder paste due to excessive adhesion on the aperture walls. Similarly, shrinking aperture opening size contributes significantly to degrading the resulting AR value. For our pad dimensions using a comparably sized aperture with a stencil thickness of 100µm the AR is < 0.35. This is a critically low AR and impractical to expect reasonable printing performance.

The decision was made to test the capability of printing M0201 pads through two differ-

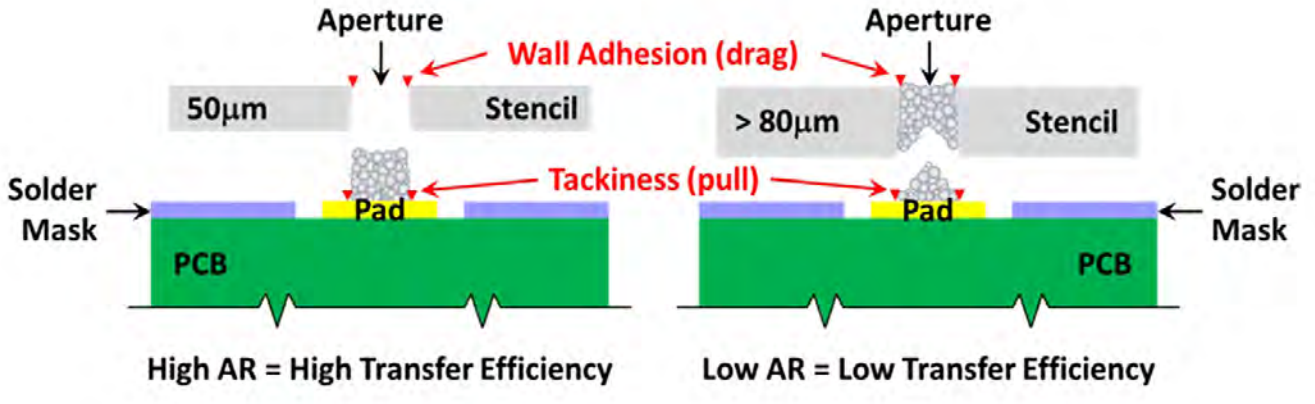

Figure 5: Stencil aperture size influence on paste transfer.

Stencil Thickness (µm)	50µm	80µm
Aperture Size (µm)	120 x 140	120 x 140
Area Ratio	0.646	0.404

Table 3: Stencil thickness, aperture size, and area ratio.

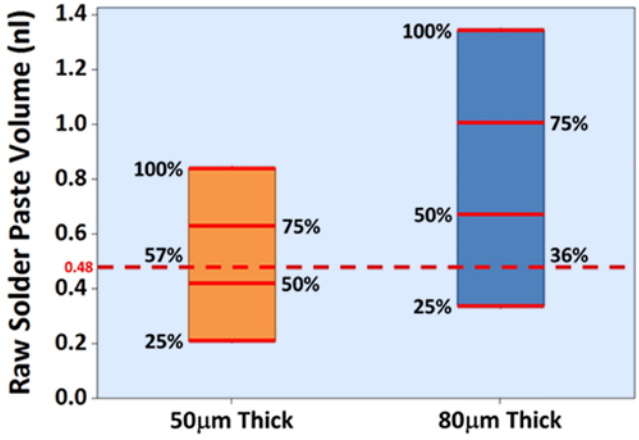

Figure 6: Solder volume transfer efficiency comparison.

ent stencil thicknesses specified at 80µm and 50µm. Table 3 identifies the Ars corresponding to the different stencil thicknesses using a common rectangular aperture size designed to print nearly the full pad area. While the thinner stencil offers the larger AR and should permit more stable printing results, such a thin foil may not accommodate delivering the paste volume required to support coarser pitch standard component types. This point will be further explained in the stencil discussion section.

Given the minimum printed solder volume requirement of 0.48nl and comparing this to the proposed stencil aperture designs, we can now identify the print volume transfer efficiency levels necessary to accommodate. Figure 6 identifies the raw solder paste volume range for each stencil thickness that correlates against 25% through 100% transfer efficiency. The important point to note here is the position of the minimum required print volume of 0.48nl with respect to the printing capability of the two stencil designs. The volume transfer efficiency required to achieve this is 57% and 36% for 50µm and 80µm thick stencils respectively.

Circuit Board

A PCB for testing the assembly capability of M0201s was designed to represent a simulated 4-up mobile phone product. Other component footprint designs include 03015M passives, 0.3mm pitch chip scale packages, and a variety of other standard component types fit for such applications. This non-electrically functional test board is 150 x 100 x 1mm with Cu/OSP pads patterned on one side and Cu/OSP exposed surface on the opposite side (Figure 7a and Figure 8). The M0201 land patterns are grouped inside each of the red circles in Figure 7a. Each circle contains 30 M0201 components, half of these positioned horizontally and half in vertical orientation (Figure 7b).

All M0201 pads were designed as non-solder mask defined (NSMD) with a single solder mask opening area containing both pads. Given the small size of these pads it was expected that

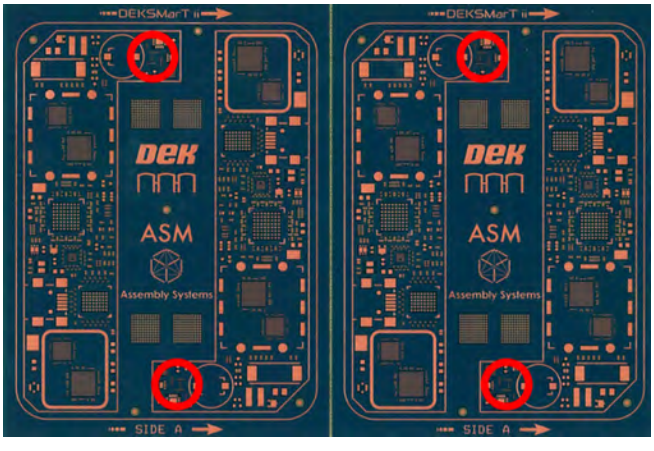

Figure 7a: Test PCB, patterned top side (side A).

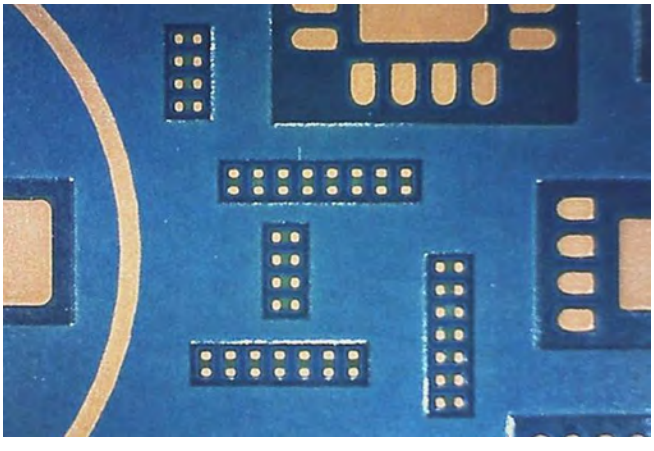

Figure 7b: M0201 pads, 30 component group.

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Figure 8: Test PCB, blank bottom side (side B).

manufacturing this design would be difficult to control dimensional accuracy. Upon inspection of the boards we found all M0201s exhibited over-etched copper at various levels of severity. This observed discrepancy in Cu pad size has been carefully considered as a potentially significant variable of influence on resulting print performance. Several categories of board quality were identified with two groups designated of interest for further print process investigation. One board group consisted of full M0201 pads and the other group included only boards with significantly over-etched M0201 Cu pads. All boards in both groups comprised acceptable solder mask registration.

Example pad specimens from these board groups are shown in Figure 9. The boards exhibiting the fullest pads were still quite rounded in the corners, decreasing the copper land area by about 10% compared to the Gerber (GBX) design. The small copper pads in comparison were over-etched by more than 80% in some instances. As shown in Figure 9, both large and small pad examples have significantly reduced solder mask window openings compared to the original GBX artwork. This attribute affects all boards.

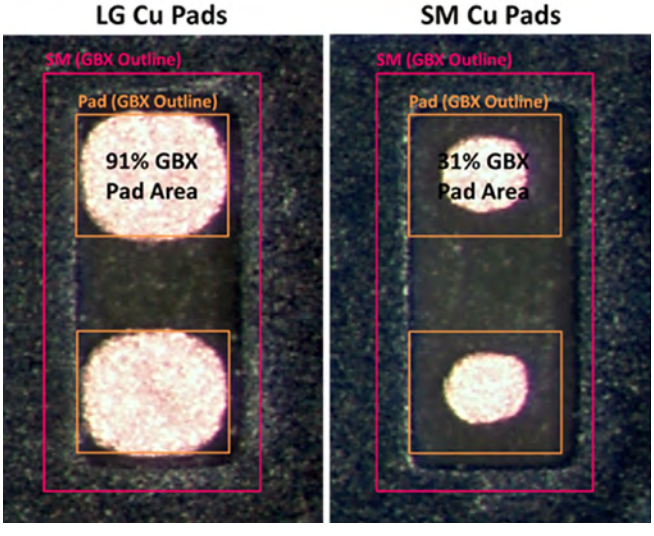

Figure 9: Variable M0201 pad quality results.

Stencil

Stencil thicknesses of 50µm and 80µm were selected to study M0201 printing performance. While the thinner stencil should facilitate easier paste transfer, the 50µm thick stencil is not likely to permit printing enough solder paste volume for the majority of components designed on the test board. A printing challenge facing M0201 implementation is the reality that uniform thickness stencil solutions cannot be so thin. Selective stencil thinning, or step stencil designs, offer a compromise to use two different foil thicknesses on one stencil. While step stencil technology has been available for many years, its utilization is typically reserved for extenuating circumstances such as this where a significant component level discrepancy in solder volume demand exists. The stencil design we have features locally stepped regions on two of the four M0201 component groups, as indicated in Figure 10, where the top of the stencil has been chemically etched to reduce foil thickness from 80µm to 50µm.

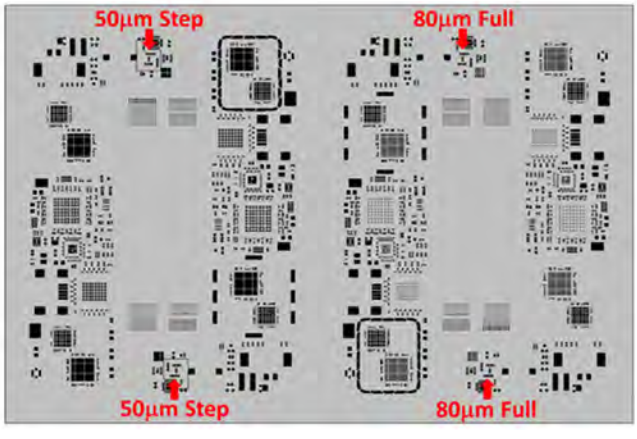

Figure 10: Stencil artwork GBX drawing.

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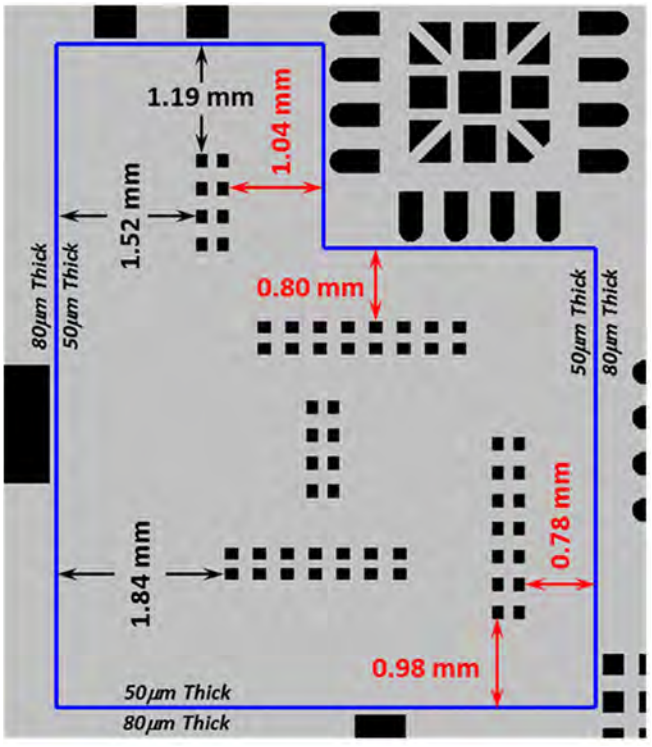

Figure 11: M0201 step area borders and violations.

A detailed view of the step area shown in Figure 11 captures the arrangement of the M0201 apertures. The clear majority of PCB designs, including this one, are not configured optimally for step stencil printing. Ideally the step perimeter is rectangular and there is sufficient clearance or "keep out" space between the apertures inset the step and the step border. The dimensions labeled in red color indicate the step border is too close to the aperture according to IPC policy illustrated in Figure 12 [7]. The K1 (i.e., keep out) zone should be > 1.08mm. Four of the six step wall perimeters violate the K1 rule. The main reason to accommodate the K1 margin is to permit enough space for a rigid squeegee to flex down into the step area and wipe the aperture top side surface clean. Any solder paste film or residue remaining on the stencil surface around aperture openings after the print stroke will destabilize transfer efficiency performance.

Two identical laser-cut, 80µm base thickness, stainless steel stencils were manufactured. Both were step etched locally to 50µm as per the previous discussion. The type of stencils made were mesh-less format foils, whereby the metal sheet comprises nearly the entire stencil area and is fitted into a 23-inch square master frame which mechanically clamps and tensions the foil. The only difference between the two stencils is that one was produced with a polymer type nano-coating applied to its bottom side and the other stencil did not have any nano-coating.

Printing performance reports based on stencil nano-coatings have been a popular publication topic in recent years [8, 9, 10, 11, 12]. As the name implies, a nano-coating is a very thinly applied material adhering to the bottom side of a metal stencil containing flux repelling properties (i.e., fluxophobicity). The original function of a nano-coating was to assist in preserving the cleanliness of the stencil bottom side by preventing premature flux and solder particle smearing. There are also claims for nano-coated stencils to deliver higher print transfer efficiency enabled by reducing the adhesion and friction of paste on aperture walls.

A sample of 16 apertures from each stencil were manually measured using a coordinate measuring machine tool. Top and bottom side stencil foil measurements were compared for the same apertures to determine average dimensions. Comparing averaged aperture size of aggregated measurements for each stencil against the GBX designed aperture size, it was verified the stencils were manufactured within 4.5µm of specification.

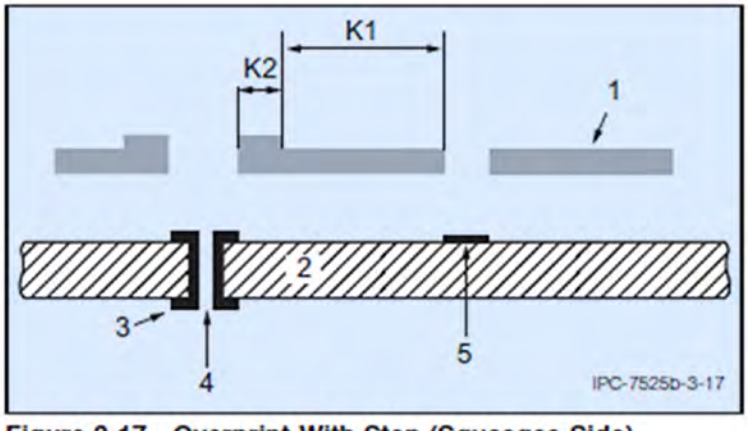

Figure 3-17 Overprint With Step (Squeegee Side)

1. Step Stencil
2. Board
3. Through-Hole Land
4. Through-Hole
5. SMT Land

Figure 12: Step stencil guidelines, IPC-7525B [6].

Print Test Preparation

The list of resources used to complete the M0201 print testing is supplied in Table 4. We decided to implement a printing process that included the most advanced and enhanced setup to create the best possible opportunity to print well. The printing machine used was a modern, well maintained, fully automatic, option loaded, state of the art model. Three key options on this machine that were used include automatic height adjusting edge snugging clamps, dedicated vacuum tooling, and ultrasonic squeegee technology. The virtues of these options have been previously reported [13, 14]. Type 5 fine powder solder paste material is recommended for miniature device printing was used exclusively. As previously described, one laser cut stencil was treated with a polymer nano-coating, otherwise the two stencils are identical.

The printing procedure consisted of using fixed process parameters of conservative, but practical levels that should accommodate mass printing tempo. To view the natural degradation of the printing process the automatic under stencil wiping process was disabled.

Printer	ASM DEK Horizon01iX
Clamps	Over Top Snugger
Tooling	Dedicated Vacuum Block
PCBs, Print Order	Number labeled boards
PCB Print Side	Side A Pads, Side B Blank
Solder Paste	Indium 8.9HFA, SAC305, NC, 88.75%, Type 5
Stencil Frame	Vector Guard 260 (23"x23")
Stencil Thickness	Step - 50µm, Full - 80µm
Nano-Coating	Sten. 1 - Nano-Coated, Sten. 2 Un-coated
USC	Under Stencil Cleaner not used
Print Speed	50mm/sec
Print Pressure	4.6kg
Separation Speed	1.0 mm/sec
Separation Distance	3.0 mm
Print Procedure	2 Dummy + 10 Meas. Prints, Uninterrupted
Print 1 Direction	Reverse
Squeegees	ProActiv Squeegee, 170mm blade
SPI Machine	Koh Young 8030-3, 10µm Camera

Table 4: Experiment tools, materials, and settings.

	Nano-Coated	Un-Coated
Bare Cu (Side B)	Test 1	Test 6
Large Pad (Side A)	Test 2	Test 5
Small Pad (Side A)	Test 3	Tests 4, 7

Table 5: Experiment variables, run order.

Each print test run consisted of two warm-up prints on blank boards, followed by ten consecutive test prints that were subsequently measured by advanced SPI equipment.

Table 5 denotes the experiment variable list and run order. Three categories of PCB include printing on the bare Cu backside of the board, large pad sorted boards, and small pad sorted boards. The stencil aperture is considered to have the best gasketing opportunity for printing on the bare Cu side, while having the worst gasketing opportunity printing on the small pads. The first three print tests involved the three different board types and were all printed using the nano-coated stencil. The remaining three print tests repeated the same process, except using the un-coated stencil. Print Test 7 was added to validate the results from Test 4.

Results

The data from the complete printing experiment outlined in Table 5 is consolidated into a single interaction plot comparing mean paste volume transfer efficiency results in Figure 13. The values in Table 6 report the specific data plotted. Data labels ❹ and ❼ (Figure 13) identify repeat Test 4 and Test 7 results. The plotted point in-between indicates the average of the two test conditions. Test 4 and 7 results are more alike to one another for the 50mm thick step stencil apertures due to a more favorable area ratio permitting easier paste transfer compared to the full 80mm thick stencil apertures. The red horizontal dashed

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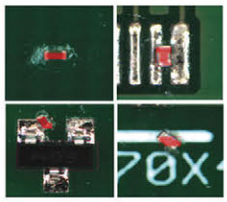

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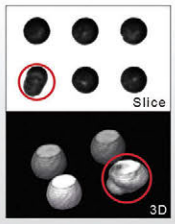

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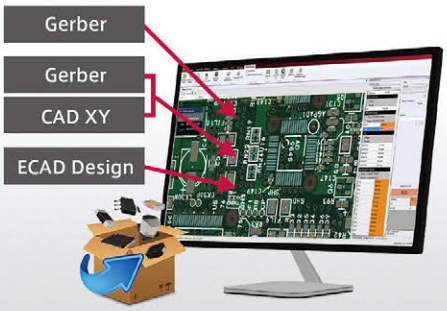

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	50µm Thick Stencil		80µm Thick Stencil	
	Nano-Coated	Un-Coated	Nano-Coated	Un-coated
Bare Cu (Side B)	102%	98%	56%	60%
Large Pad (Side A)	125%	109%	69%	61%
Small Pad (Side A)	124%	116%, 114%	71%	53%, 65%

Table 6: M0201 mean paste volume data.

line highlights the 70% paste transfer efficiency threshold which is a common transfer efficiency target for standard printing applications. The data is quite distinctively divided above and below this threshold, with the all the 50mm thick step stencil apertures performing at or above 100% average TE and all the full 80mm thick stencil apertures performing at or below 70% average TE. This divided pattern supports area ratio logic.

Further interrogation of the data shows the bare Cu printed boards to yield lower paste transfer than the NSMD Cu pads in 3 of 4 instances. The PCB topography introduced by solder mask openings and patterned metallization leads to improper stencil gasketing during the aperture fill process, likely allowing the additional paste volume to be deposited. For both LG and SM Cu pads, the nano-coated stencil results in overall solder paste transfer efficiency improvement compared to the un-coated stencil. The only condition where stencil nano-coating has a negative influence on average paste transfer is for the full 80mm thick stencil apertures printed on bare Cu. Reference [10] also reports average volume paste transfer efficiency data where the nano-coated stencil produces less paste volume (compared to an un-coated stencil). It is explained in [10] that the nano-coating assists to improve the shape of the print deposits to more closely resemble the true form of the stencil aperture. In contrast, the un-coated stencil may produce printed deposits that exhibit some shape distortion that contributes to inflated transfer efficiency values.

While the logic for improved solder paste deposit shape ascribed to a stencil nano-coating seems reasonable, this does not make complete sense upon considering the standard deviation data. The same 80mm thick stencil aperture print results on bare Cu boards exhibits a contradicting trend as shown in the standard deviation interaction plot of Figure 14. The values in Table 7 report the specific data plotted. An improved solder print deposit shape should also correlate to better uniformity marked by reduced standard deviation value, which in fact has not occurred for the nano-coated stencil result. Our explanation for this reduced printing capability is the discovery of a unique set of conditions for which the function of a stencil nano-coating hinders printing performance. Such conditions are now thought to consist of a stencil nano-coating in combination with challenging aperture area ratio designs while printing onto a flat surface where the stencil gasket condition is ideal. Additional validation testing is required to grow confidence in this fresh hypothesis.

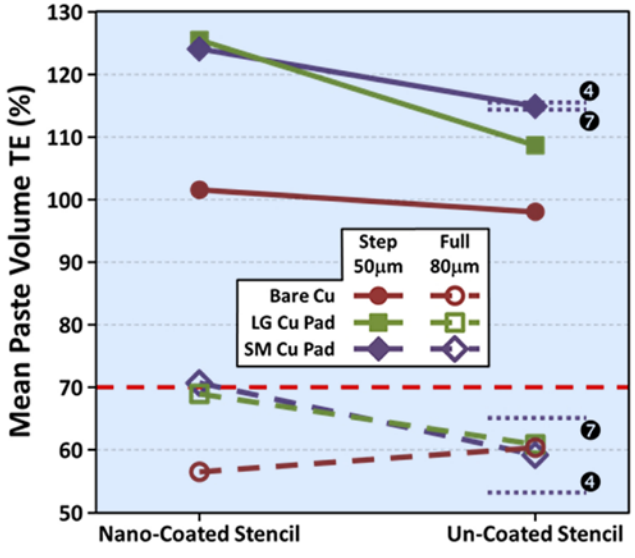

Figure 13: M0201 mean paste volume trends.

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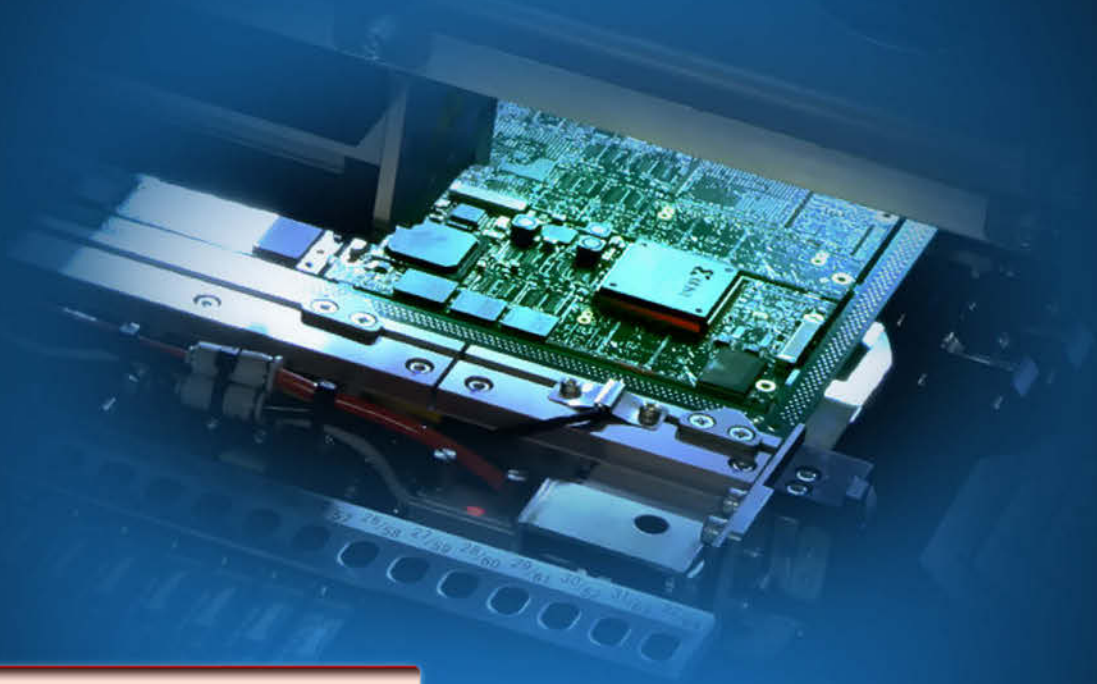

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	50µm Thick Stencil		80µm Thick Stencil	
	Nano-Coated	Un-Coated	Nano-Coated	Un-coated
Bare Cu (Side B)	9%	11%	12%	10%
Large Pad (Side A)	20%	28%	15%	17%
Small Pad (Side A)	24%	35%, 35%	12%	26%, 22%

Table 7: M0201 paste volume standard deviation data.

Further review of Figure 14 shows the nano-coated stencil apertures improved standard deviation for all test conditions except for the 80mm stencil apertures printing on bare Cu. The effect of nano-coating apertures appears to have the greatest performance benefit for the SM Cu pads, improving standard deviation by at least 10%. Also, in 3 of 4 cases, the SM pad print uniformity is worse than the LG pad result, despite showing nearly equal average TE values. The main reason for replicating Test 4 (❹) with Test 7 (❼) was to confirm the occurrence of large standard deviation and significantly insufficient deposits to be reproducible. This was indeed proven. Another feature of the graph is the red dashed horizontal line indicating the 10% standard deviation level which marks a common threshold identifying print process control. Values above this typically indicate undesirable printing deposit uniformity, which is the case for nearly all our data. The most controlled print volume distributions result from printing on the bare Cu (i.e., smoothest surface). It is somewhat unexpected to see the higher area ratio apertures designed on the thinner 50mm step stencil producing consistently higher print deposit scatter compared to the low area ratio stencil apertures on the thicker 80mm foil. The explanation for this is the inability for the squeegee blade to effectively wipe the solder paste cleanly inside the step pocket area. As previously indicated in Figure 11 the step size and geometry is not optimal. A favorable aperture area ratio design is not enough to compensate for a poor stencil wipe.

Another view of the M0201 data considers the raw print volume distribution results in the boxplots on Figure 15. It was earlier described in Figure 4, a model for estimating the lowest solder volume accomplishing an acceptable soldered termination result. The result in Table 2 indicates a raw print volume of 0.48nl satisfies this requirement and is identified in Figure 13 as the dashed horizontal red line. It is useful to view this threshold against the raw solder paste print data to improve judgment on M0201 printability. The only test condition which supplied enough solder paste on all ten prints is the 50mm thick step stencil nano-coated apertures. This result may actually be enabled by a poor stencil wipe as the side effect of this can be additional paste volume, confirmed by the high TE reported in Figure 13. Another interesting general observation here is the similarity of raw print volume distributions when comparing the 50mm thick step stencil data against the full 80mm thick stencil. While we may expect to see more physical

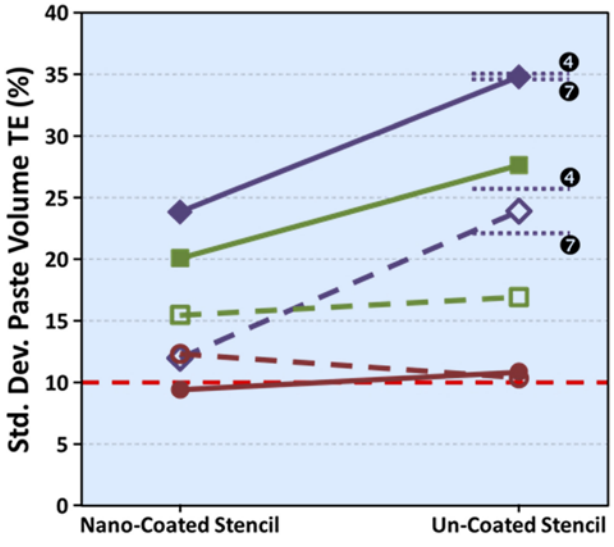

Figure 14: M0201 Paste volume standard deviations. (same legend applies from Figure 13).

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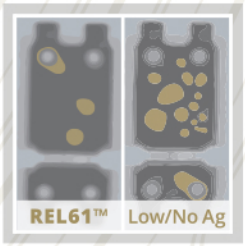

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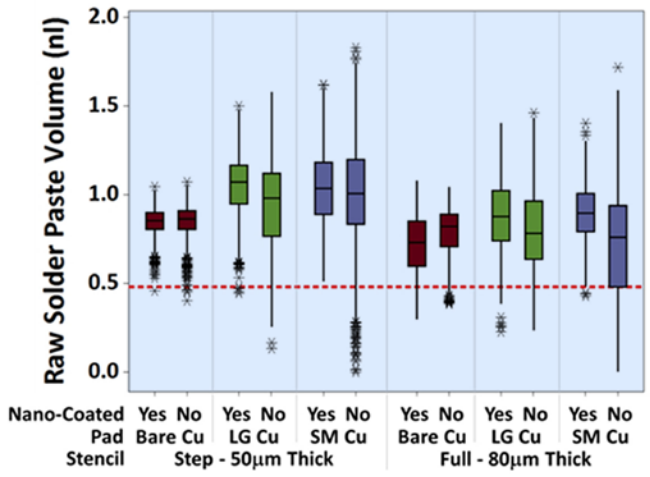

Figure 15: Raw volume boxplot - all prints combined.

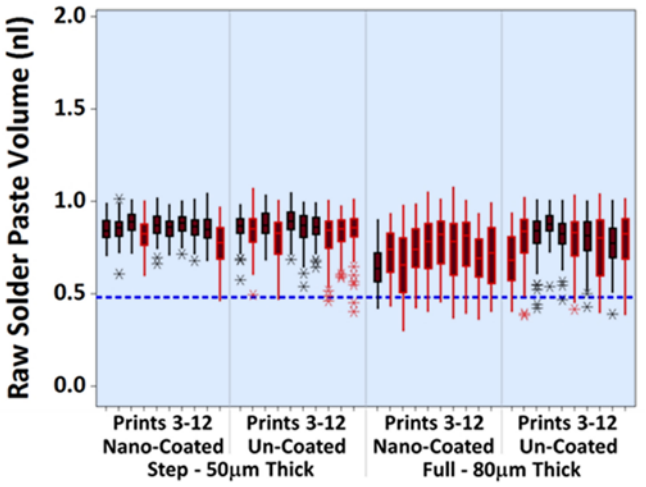

Figure 16: Individual print boxplots - bare Cu pads.

paste volume delivered by the thicker foil, the trend in fact is just the opposite with the thinner foil supplying more volume. Reasoning for this is the combination of a more challenging area ratio on the 80mm thick stencil that limits paste transfer efficiency along with the poor stencil wipe condition inside the 50mm thick step areas which boosts print volume. Further review of Figure 15 results show there are a few test conditions that nearly satisfy the minimum 0.48nl paste volume requirement. The data distributions can be dissected in more detail by exploring the raw print volume distributions on an individual print basis, which is explored in Figures 16, 17, and 18.

While the format of the boxplots in Figures 16, 17, 18 are labeled for clear interpretation, two key performance metrics necessitate clarification. First, the 0.48nl paste volume threshold is drawn in these plots now as a blue colored dashed horizontal line. Second, the outline color of the individual boxplot is either red or black. Red boxplot outlines indicate the print volume distribution exceeds a volume transfer efficiency standard deviation value of 10%. Black boxplot outlines indicate the standard deviation is less than 10%. The objective for investigating these detailed boxplot views is to determine which data, if any, can satisfy both conditions (i.e., > 0.48nl, < 10% Std. Dev.). Figure 16 contains several occurrences of compliant data, representing the printing process test on bare Cu boards. The flatter board topography is considered a significant advantage towards achieving highly uniform prints. Despite the challenge of efficient squeegee wiping inside the 50mm thick step area, several boards were printed quite well. Fewer successes were reported with the thicker 80mm apertures, as expected with lower area ratio apertures.

The print by print results in Figure 17 contains LG pad data. Some of the boards printed with nano-coated stencil apertures satisfy the 0.48nl paste volume requirement, however, none of

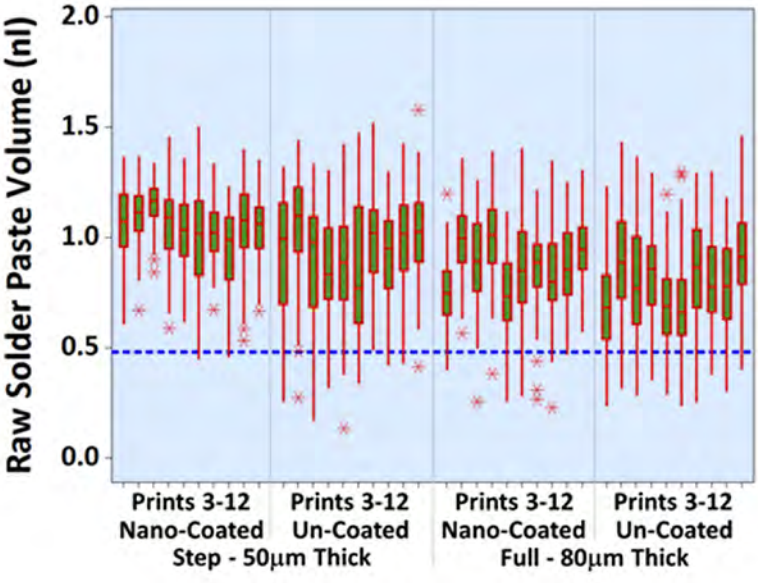

Figure 17: Individual print boxplots - large Cu pads.

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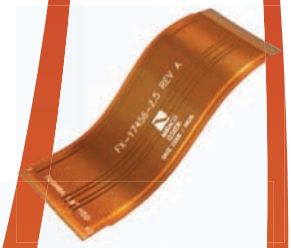

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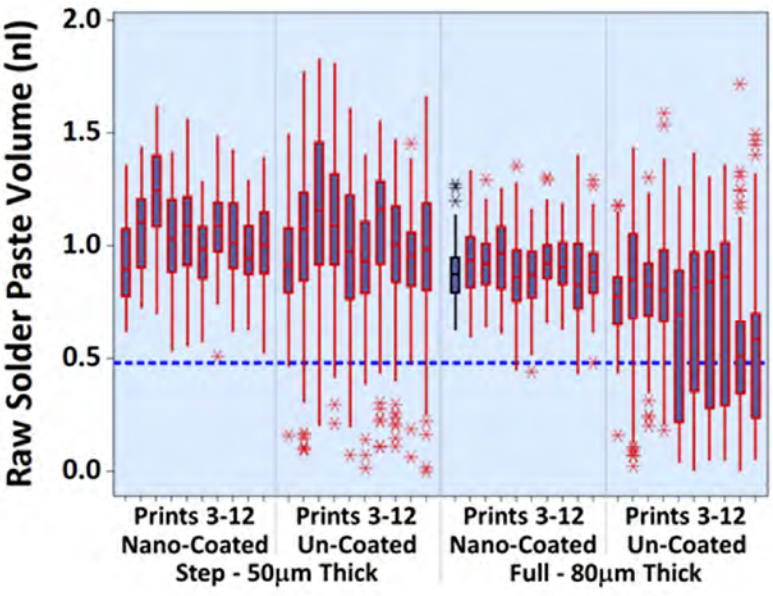

Figure 18: Individual print boxplots - small Cu pads.

the prints demonstrate less than 10% standard deviation.

The print-by-print results in Figure 18 contains SM pad data. Only one in 40 boards satisfies the 0.48nl paste volume and 10% standard deviation criteria. The benefit of the stencil nano-coating is particularly obvious for this data set as an extreme number of low volume outliers occur on boards printed with the un-coated stencil.

Conclusion

The results of this printing research largely support the printing capability benefits offered by using nano-coated stencils. The largest benefit observed from the nano-coating was reduced print volume distribution scatter, particularly on the circuit boards with small undersized Cu pads. The discovery of one unique test condition combination that produced poorer printing performance with the nano-coated stencil is currently unexplainable and warrants further review to confirm consistency of this behavior.

This work has also identified the effect of pad structure to have profound influence on printing results, with the planar bare Cu board surface performing stand-alone best. However, demonstrated printing capability on bare board surfaces does not guarantee the same success on real patterned PCBs. Board design and manufacturing quality can significantly influence the printing outcome. While average print volume transfer efficiency results were similar comparing large pads against small pads, the print volume uniformity was noted better on large pads.

M0201 printing capability on proper circuit board pads proved to be best controlled using the 80mm thick nano-coated stencil despite the unfavorable area ratio compared to the 50mm thick step stencil results. The 50mm thick step stencil apertures printed much larger than expected paste volume and produced a wider scatter in the print volume distribution attributed to poor squeegee wipe efficiency inside the step area.

Further Work

Work will continue to improve print quality results on both 80mm thick and 50mm thick stencil foils on this test board. A subsequent M0201 full assembly and reflow experiment is currently in plan. **SMT007**

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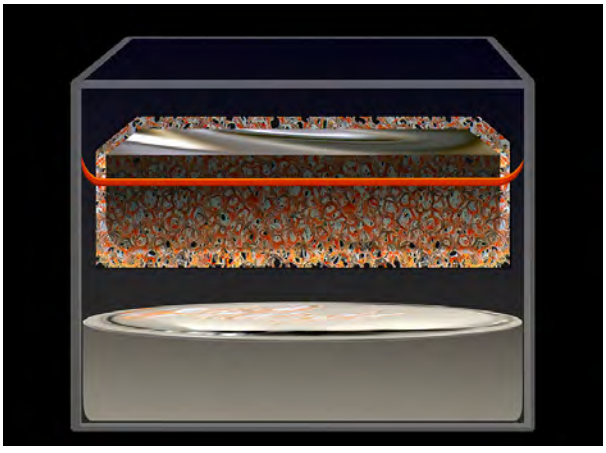
A New Approach to Rechargeable Batteries

A type of battery first invented nearly five decades ago could catapult to the forefront of energy storage technologies, thanks to a new finding by researchers at MIT. The battery, based on electrodes made of sodium and nickel chloride and using a new type of metal mesh membrane, could be used for grid-scale installations to make intermittent power sources such as wind and solar capable of delivering reliable baseload electricity.

Although the basic battery chemistry the team used, based on a liquid sodium electrode material, was first described in 1968, the concept never caught on as a practical approach because it required the use of a thin membrane to separate its molten components, and the only known material with the needed properties for that membrane was a brittle and fragile ceramic.

After experimenting with various compounds, the team found that an ordinary steel mesh coated with a solution of titanium nitride could perform all the functions of the previously used ceramic membranes, but without the brittleness and fragility. The use of the new type of membrane can be applied to a wide variety of molten-electrode battery chemistries and opens up new avenues for battery design.

The findings were reported in the journal Nature Energy, by a team led by MIT professor Donald Sadoway, postdocs Huayi Yin and Brice Chung, and four others.



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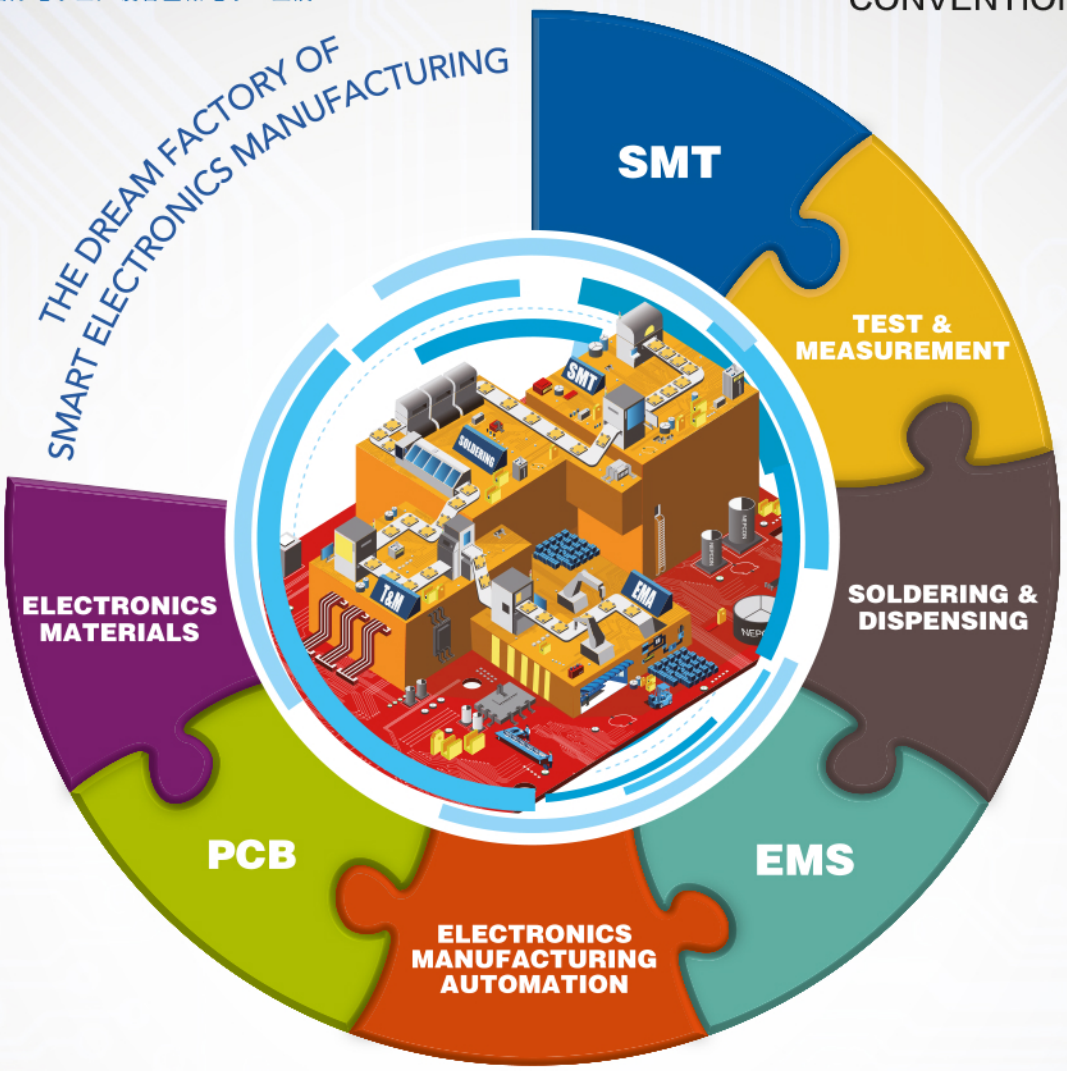

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Electronics Industry News and Market Highlights

Wearable Technology Market to Grow Over $25B in 2018 ▶

In its new report, Visiongain forecasts the global wearable technology market to reach past $25 billion in 2018.

Spending on Internet of Things in CEE to Exceed $11 Billion in 2018 ▶

Spending on the Internet of Things (IoT) in Central and Eastern Europe (CEE) is forecast to reach $11.2 billion in 2018, an increase of 15.5% over the $9.7 billion recorded in 2017, according to the International Data Corporation (IDC) Worldwide Semiannual Internet of Things Spending Guide.

PC-Based Automation Market Worth $38.01 Billion by 2023 ▶

The PC-based automation market is expected to grow from $29.92 billion in 2018 to $38.01 billion by 2023, at a CAGR of 4.9% between 2018 and 2023, according to MarketsandMarkets.

Lithium and Cobalt Markets Set to Grow ▶

According to a new report published by Transparency Market Research, the global lithium-ion battery market is expected to reach $77.42 billion by 2024, at a compound annual growth rate of 11.6 percent from 2016 to 2024, mainly driven by the increasing need for clean energy.

India's External Storage Systems Witnessed Increased YoY Spending in Q3 2017 ▶

India's External Storage Market witnessed marginal 0.4% growth YoY (by vendor revenue) and stood at $66.4 million in Q3 2017 according to IDC's latest Asia/Pacific Quarterly Enterprise Storage Systems Tracker, Q3 2017.

Edge Computing Market to Grow at 30% CAGR from 2018 to 2022 ▶

TrendForce forecasts that the edge computing market will grow by a compound annual growth rate (CAGR) of over 30% from 2018 to 2022.

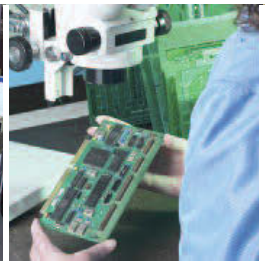
Wearable Medical Devices Market Worth $14B by 2022 ▶

MarketsandMarkets expects the wearable medical devices market to reach $14.41 billion by 2022 from $6.22 billion in 2017, at a CAGR of 18.3%, mainly due to the technological advances in medical devices, increasing penetration of smartphones and growing number of smartphone-based healthcare apps compatible with wearable devices, and increasing awareness about physical fitness.

China's Wafer Fabrication Industry Sees Intensified Competition in 2018 ▶

According to TrendForce's latest report, Breakdown Analysis of China's Semiconductor Industry, many fabs are being built in China with high capital expenditures, attracting attention from the industry.



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Is it a Cloud or is it Fog?
The Climate Change of Data

Accelerating Tech–Insights from the Smart Factory

Feature Column by Michael Ford, AEGIS INDUSTRIAL SOFTWARE CORP.

I have started to hear people referring to their cloud-systems as "the fog." I sense that the witticism here is hiding a very real experience. In our industrial past, we do have a history of simply venting gases into the atmosphere, so is the same happening in this digital age to our data? Can we just dump data into a cloud and hope that some very clever analytic software will sort it out for us when we need it? The real answer lies with understanding what the cloud can really offer, what it cannot, and what is needed to build the cloud into an effective strategy for data storage and accessibility.

The Search Engine Experience

Search engines, such as Google, have really spoiled us over the years, setting our expectation to be able to find something specific from the seemingly unlimited amount of information out there, by typing just a few words or saying a simple sentence. Trying to imagine the sheer volume of data that these search engines access, which we expect is in some kind of cloud, through which the search engine algorithm needs to go through to deliver the result in less than a second, is mind-boggling. The search engine is a great example of a cloud-

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based system. Other than the simple user interface, none of the software is on your device, and other than the result of the search, none of the data. Search engines are designed to be extremely well optimized to cope with, let's call it "human" data, the majority of which was not created with searching in mind. It then takes a human mind to select the results that make sense, which may not be the one at the top of the list. As the internet has matured, search engine optimization (SEO) techniques have been created which embed key items of data within web pages designed to help search engines understand the content and intent of the web data. Even for humans, just random data in the cloud is not good enough.

Considerations of Cloud Storage

Web pages on the Internet do not of course reflect the true nature of cloud data storage. From a typical manufacturing standpoint, cloud storage is simply another way or place in which to put data. From a usage perspective, many see it as being no different from an on-site server (now marketed as a "local cloud") or even the external hard disk on your laptop (now marketed as your "personal cloud"). Off-site cloud storage is vast and can easily be cost effective, requiring no maintenance or fixed overhead other than paying the service bills. There are however a couple of very important things to consider with cloud storage.

Off-site cloud storage is vast and can easily be cost effective, requiring no maintenance or fixed overhead other than paying the service bills.

Firstly, you must trust that there is appropriate security in place, and in some cases, for example with ITAR restricted data, make sure that the physical storage distribution is within friendly places. Cloud data is generally physically spread across data-centers all over the world and will naturally be driven towards areas that offer lower costs. Adequate security for data access must be provided.

The second thing to consider with cloud data storage is the requirement for how the data will be accessed. Links from a site to the cloud have a finite speed, which is basically the Internet connection. Though theoretical upload and download speeds may seem quite fast these days, these same connections are supporting the email system, as well as everyone in the company on a browser, and even the coffee machine these days. Mission critical systems must share bandwidth with an increasing number of devices and services unless equipped with dedicated lines.

Limited connection speed is all very well for the continuous trickle of upload data, but once up there, it is rather impractical to ever consider downloading all the data again. As with the search engine example, if your data and software are both in the cloud, system performance and capability will not be limited by connection issues. In many use-cases, this is fine, for example the use of enterprise-grade Business Intelligence tools to look at longer term statistical trends.

The Practical Bottleneck

With a general search, like standard Google in a browser, we as humans have to try to interpret and select the results that make sense. We see now however that technology such as Siri, Cortana, Alexa, Echo, etc., are trying to become much smarter, to be able to deliver an answer to a question which is not just a list of web pages that might be of interest. To do this, there is another level of data organization required, over and above standard SEO techniques. It has taken quite some time, and a huge amount of investment to make this happen by companies behind these products, as they are trying to convert random data into meaningful information. This has always been the same key bottleneck for any computer system, cloud-based or

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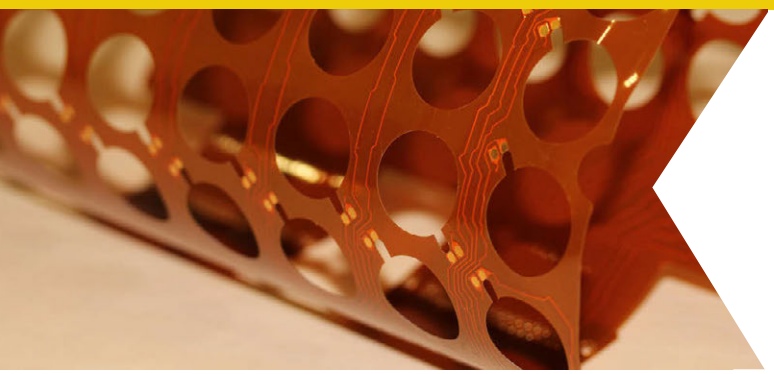

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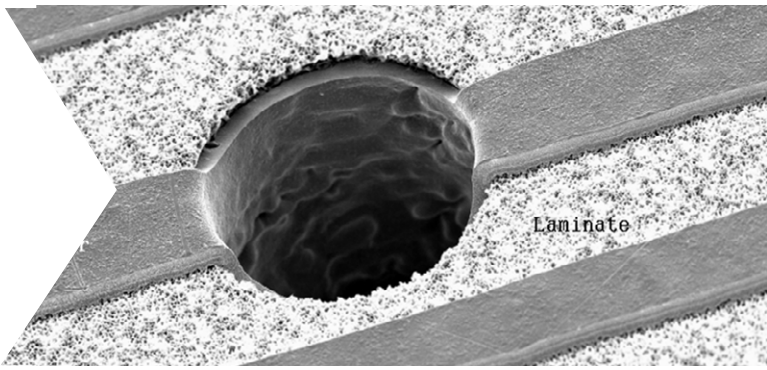

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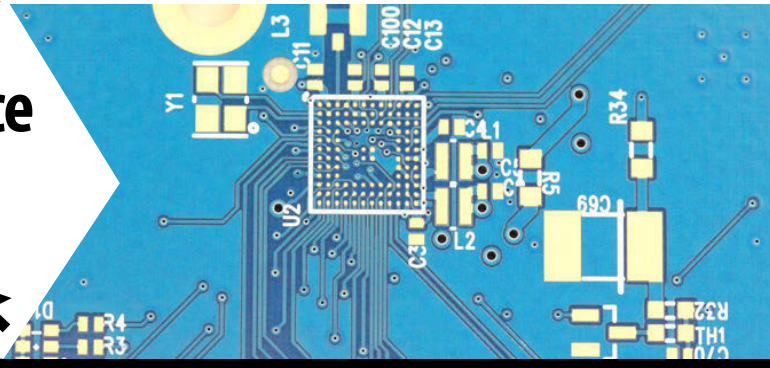

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not. The clearer meaning the elements of the stored data have, the easier it is to create value, which is the politically correct way of saying "Garbage in, garbage out".

Lightening the Cloud

There are many applications and solutions that are ideally placed in the cloud, especially where potentially huge amounts of data storage will be processed. Examples could be capacity plan reports, long term quality and productivity metrics, traceability data analysis. The question is then to decide what software should exist in the cloud to provide these functions.

There are many enterprise-grade packages available, which provide easy ways to configure data search criteria and the format for reporting, such as business intelligence (BI). Unfortunately, the practical bottleneck rules come into play. For such off the shelf analytic systems to work effectively, the data itself must be highly organized and meaningful. Data obtained directly from manufacturing processes is usually quite the opposite. For example, a machine that reports events such as "stop other than error" or "waiting for PCB" have very little meaning in isolation. When put into the cloud, there would need to be extensive processing to find out the cause, for example why the machine had to wait for a PCB, which potentially comes from a variety of sources. A massive and complex analysis of a whole set of such simple events, of which there can be thousands every hour, is needed to try to figure out the true information for every step of the analysis. A typical BI application is going to be impossibly stretched to provide an algorithm that can do this effectively, understanding the nature of raw production data. An alternative to the off the shelf approach would be to develop a bespoke "raw production data processor" in the cloud which would be very complex and expensive to develop and support.

Intelligent processing of data locally at the production site before the data goes into the cloud is critical for the ability for cloud-based solutions to work effectively, exactly like the advanced SEO data associated with web-pages. The first stage is to listen and piece together the multiple disparate data elements in strict time sequence, derived from different kinds of machines, bar-code readers, sensors, material preparation transactions, etc. Qualified events can then be created, which is the conversion of raw data to create information. These events are meaningful and actionable pieces of information. When out into the cloud, a great deal more value can be obtained with a mere fraction of the processing, and hence cost.

The Hybrid Theory

Processing data locally is already a part of an advanced MES system that has direct connections and the ability to process data directly from both automated and manual production operations, as well as to manage them. Starting with dashboards, which need to be fed meaningful events as they happen, then generating alerts based on a live situation, the real-time data processing requirement is already well established. We are already experiencing the extension of this processing, as we see the use of data in real-time by a new generation for "smart" systems such as those associated with

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This event will explore the market opportunities, emerging applications, and materials and process requirements to provide this functionality at an affordable cost. You'll hear from experts in polymers and other flexible materials, effects of complex packaging structures on signal integrity, speed and power consumption, and the latest and most promising technology for heterogeneous packaging. Topics will also include cutting edge/niche concepts in medical implantable devices and "synthetic skin", etc.

The challenges include:

- **Handling and protecting thin and small components made from brittle materials (silicon, III-V compounds, etc.)**
- **Flexible interconnects on a wide range of scales from microns to millimeters**
- **Reliability with thermal expansion coefficients of different components ranging from a few ppm to hundreds**
- **Cost-effective process techniques for putting it all together**

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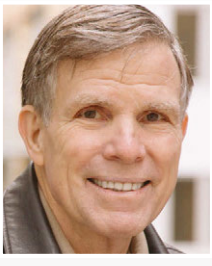

An Alternative History of the Electronics Manufacturing Industry

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Industry 4.0. Use of results of cloud-based data analysis is simply not timely or suitable for these kinds of applications. Any delays, for example, in the event of specific control of production machines, reacting perhaps to a product arriving for processing which needs to be qualified for routing conformance, beyond a sub-second cannot be tolerated, otherwise productivity is compromised. Due to upload restrictions, data getting into the cloud from manufacturing can become minutes or even hours old by the time it gets there.

It is therefore inevitable that there is the need for compatible software on both sides of the cloud/site divide. An effective hybrid model would perform data acquisition on the shop-floor, processing it in a smart way to convert it into discernable events or facts. These are then easily utilized by dashboard, local alert generation analysis, smart Industry 4.0 functions, and then ultimately the clear meaningful record in to the cloud for more advanced and long-term analysis. With compatibility between software both in the cloud and at the site, maximum value can be obtained with the minimum of overhead.

The use of data in the cloud and cloud-based systems for manufacturing data can become practical, really achieving expected values. The cloud is no longer the fog that some people have begun to experience. Though cloud technology is relatively new, the fundamental "GIGO" principle remains the same. **SMT007**

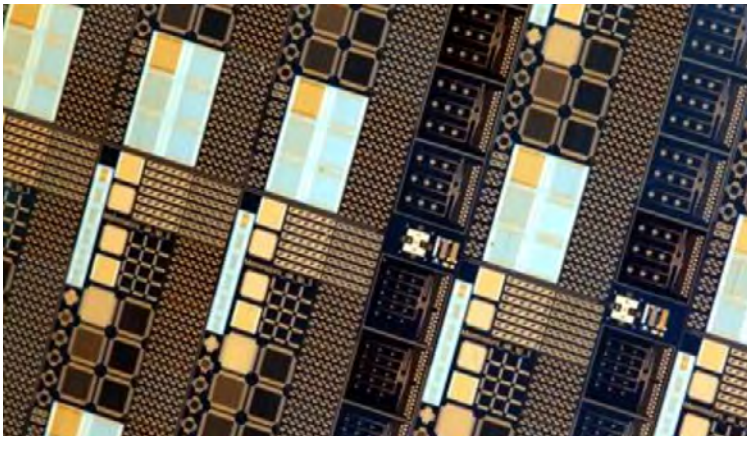
Michael Ford is the European marketing director for Aegis Software.

New Tech Standard Could Shape Future of Electronics Design

Researchers from Electronics and Computer Science at the University of Southampton have discovered a way of enhancing the capabilities of an emerging nanotechnology that could open the door to a new generation of electronics.

In a study published in the journal Scientific Reports, researchers show how they have pushed the memristor to a new level of performance after experimenting with its component materials.

Memristors could hold the key to a new era in electronics, being both smaller and simpler in form than transistors, low-energy, and with the ability to retain data by 'remembering' the amount of charge that has passed through them - potentially resulting in computers that switch on and off instantly and never forget.



The researchers demonstrated a new memristor technology that can store up to 128 discernible memory states per switch, almost four times more than previously reported, by evaluating several configurations of functional oxide materials - the core component that gives the memristor its ability to alter its resistance.

"This is a really exciting discovery, with potentially enormous implications for modern electronics. By 2020 there are expected to be more than 200 billion interconnected devices within the Internet of Things framework - these will generate an incredible amount of data that will need processing. Memristors are a key enabling technology for next-generation chips, which need to be highly reconfigurable yet affordable, scalable and energy-efficient," said Themis Prodromakis, Professor of Nanotechnology and EPSRC Fellow at the University of Southampton.

This memristor technology will be showcased at ISCAS 2018, an international circuits and systems conference, in Florence, Italy, in May.

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Device "Dead Bugging"

Knocking Down the Bone Pile

by Bob Wettermann, BEST INC.

"Dead bug" attachment of electronic components is a way of building functioning electronic circuits by soldering the parts directly together or by soldering miniature jumper wires between the component leads and the PCB lands instead of the traditional surface mount or through-hole soldering of components onto a printed circuit board (PCB). The dead bug electronic component attachment was named because when you invert the IC and bend the legs out it will look like a dead bug.

There are numerous reasons why this method of electronic component attachment would be done as part of the PCB rework process:

- The component is nonstandard or you do not have a library design for the pad configuration of the component
- A board modification or "re-spin" takes too long from beginning to end
- A layout error and the package configuration does not match the board layout
- The device may be available in the time you need it, but not in the device package configuration of your design
- It is an easier and or less expensive method to test a concept before putting in the time and effort to get boards fabricated, thereby making it useful for prototyping

Several weaknesses are related to a dead bug attachment of a device to a PCB. Once the dead bug modification has been made, it is very difficult to modify or rework this part of the PCB. With the electronic component many times being encapsulated to provide mechanical rigidity, re-working the dead bug becomes

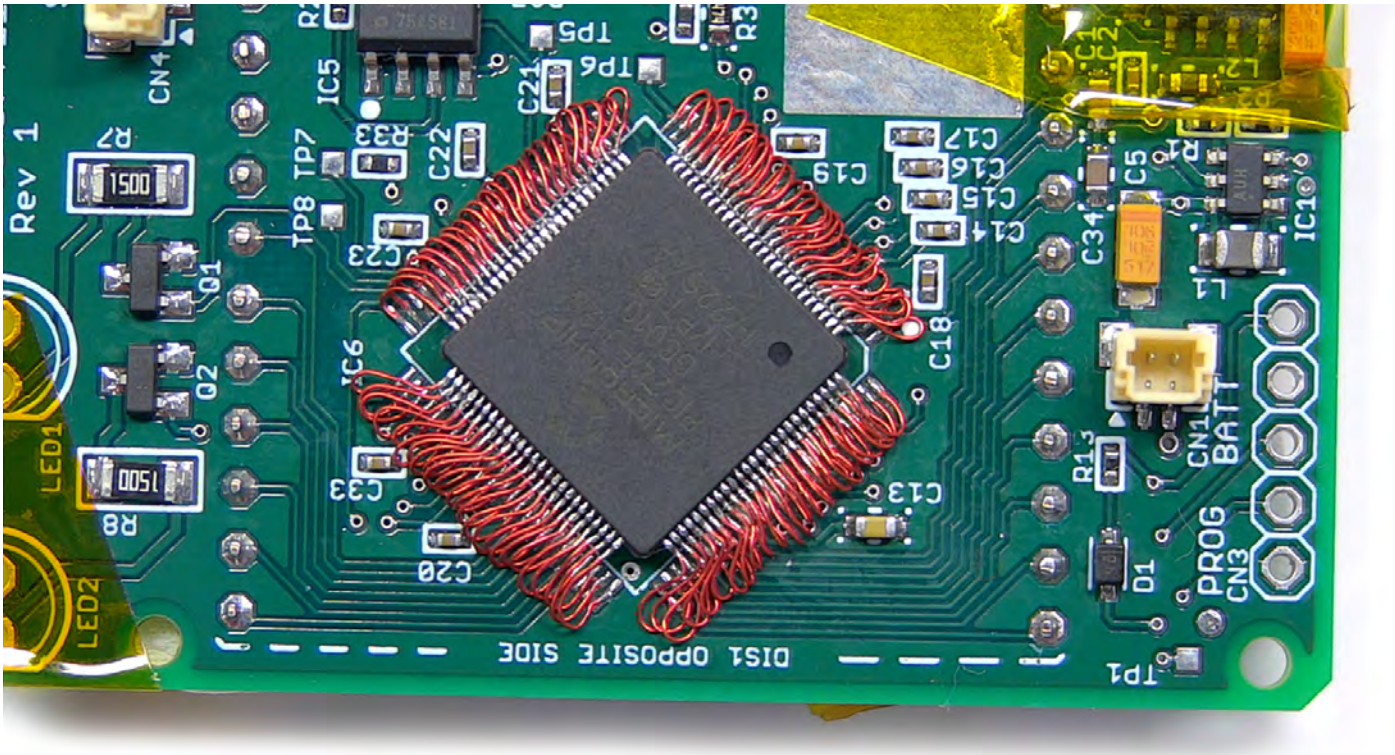

Figure 1: Dead bug attachment of QFP to different pads on a PCB due to a layout problem.

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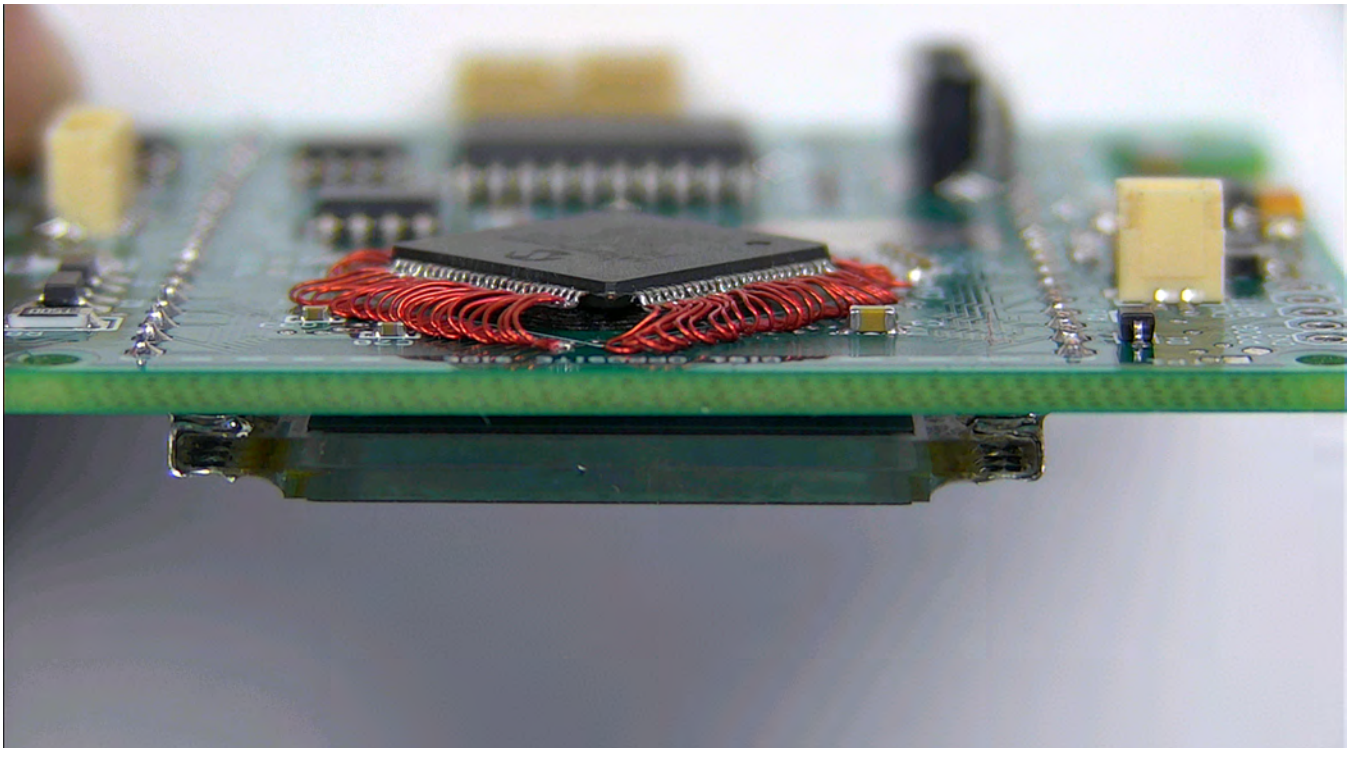

Figure 2: The dead bug technique may only be able to be completed by the most skilled people.

very difficult. The dead bug component is not mechanically robust. While this may be a way to attach an electronic component for prototyping or experimentation in any real end-use operating environment, vibration, heat or physical handling may cause a disconnection to occur. For RF or capacitive sensitive circuits, it is difficult to repeat exactly how a dead bug attachment was made. This attachment technique will get you by in the moment, but it will be difficult to exactly replicate with the same length of jumpers or glue. Finally, the dead bug technique is one that takes a highly-skilled soldering technician many hours, and in some cases (like the example presented in the embedded photos) it may only be able to be completed by the most skilled people. As the complexity for the circuit or components increase it makes it more and more difficult to keep all the connections straight and separated.

There are several things to keep in mind when performing a dead bug attachment of an electronic component. Solid wires should be used as they tend to keep their shape and bend more consistently than stranded wire. Make sure to stake the component so as not to break the small jumper wires found in the dead bug attachment. Usually this involves some form of gluing the component and/or jumper wires to the PCB. This will help to stabilize the connections during the testing phase of the development. In addition, make sure that the person completing the soldering is working from some type of print. This might include pin out information of the component package as well as pad definitions on the PCB. This will assist in any debugging and later troubleshooting.

Dead bug soldering of a component to another component or to a PCB is challenging work, but it may be a fast answer to the question of whether the circuit or the PCB functions according to the circuit designer's wishes. **SMT007**

Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago.

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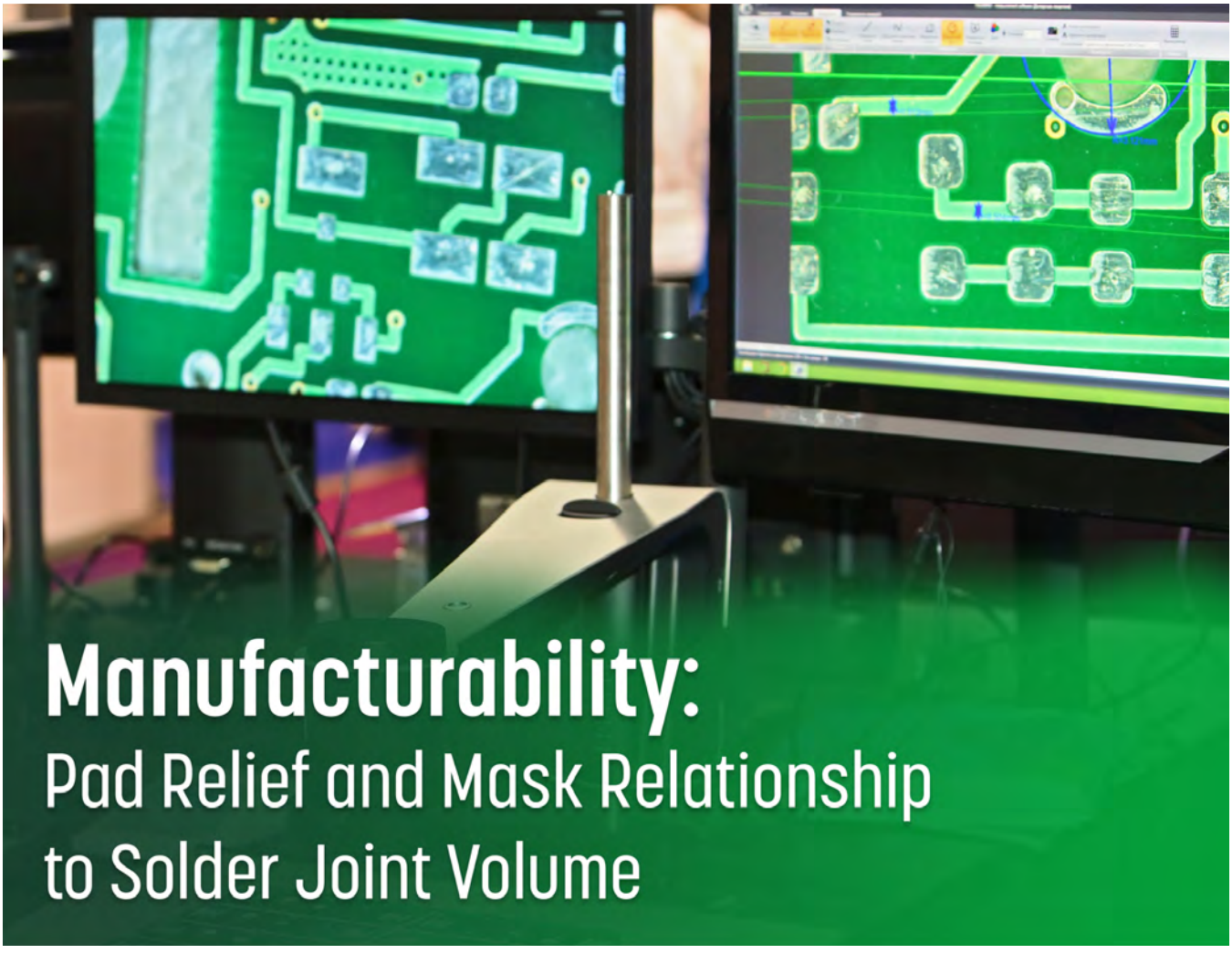

Manufacturability: Pad Relief and Mask Relationship to Solder Joint Volume

Article by Ken Horky
PETERSON MANUFACTURING

Electronic assembly thermal management has always been an issue but has become more significant as we pack more power and function into a smaller form factor. In recent years, the growing use of LEDs for illumination on a large scale has presented additional thermal demands. EMI control also benefits from generous copper use.

The first inclination for a designer is to add copper in the form of planes and flooding. How this copper is added with respect to the component footprint's pads can alter the termination quality.

Calculating the area for each pad:
Cu-D = 63.0(L1), 11.8(W1)
Oval Pad = ((63-11.8) *11.8) + (PI() *(11.8/2)^2) = 714
+ Partial Rectangular Trace = 5.0*3.0 = 14.5, 14.5 + 714 = 729
Msk-D = 73.0(L2), 16.5(W2)
Unmasked Rectangular Copper Area = 73.0*16.5 = 1205

Where:
Cu-D = Non-solder mask defined or copper defined pads
- Pad features are created by the copper etching process in fabrication.

Msk-D = Solder mask defined pads
- Pad features are created by the respective solder mask pattern applied over copper, post etching in fabrication.

The Msk-D pad is 65% larger than the Cu-D pad.

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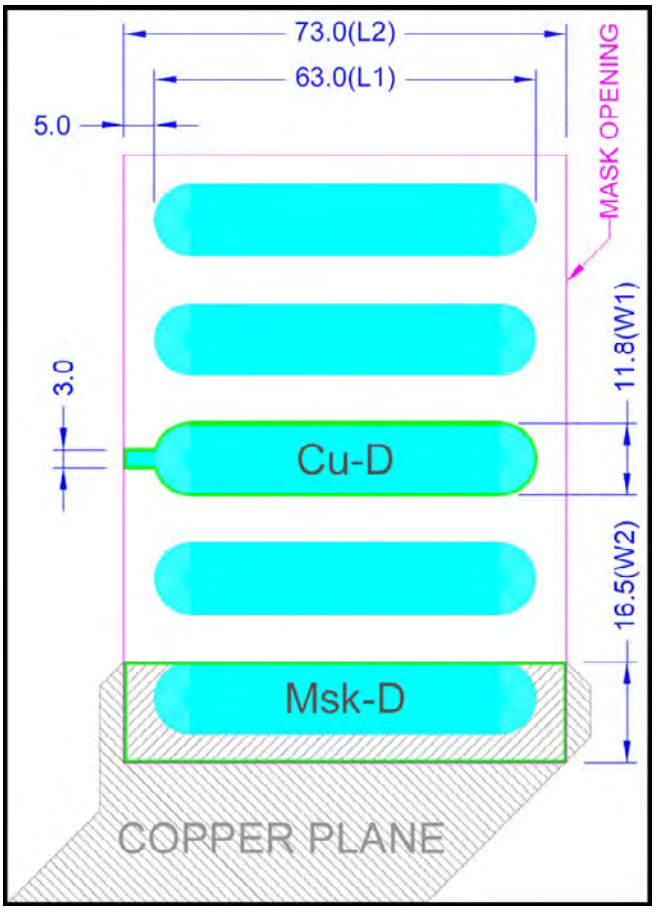


Figure 1: Graphical representation of the pad definitions with example dimensions.

For simplicity, we'll assume the solder paste deposition aperture is equal to the original pad size (often it is less). For the Cu-D pad, the trace to the pad adds relatively little additional copper area, creating only an additional 2% copper area to the pad. For the Msk-D pad, the surrounding copper plane adds significantly more copper area, 1.7X. Solder paste will occupy an area of 714 out of 1205 total pad area. This leaves 41% of the Msk-D pad area unaccounted for in solder joint volume. The post reflow results will be less interconnect volume at the termination. Without sufficient solder volume, the minimum fillet height may not meet your acceptance standards. The spoke width of thermally relieved pads can have the same effect on termination quality as an Msk-D pad. Pad size relative to mask expansion directly affects the magnitude of the issue.

In the example above, the Msk-D pad is 1.7 times larger than the original pad design using 5 mil mask expansion. If the pad was 10 times larger, using the same mask expansion, the Msk-D pad would only be 1.1 times larger. The smaller the pad, the greater the impact of mask defined pads.

Some variables to consider:

1) In design:
   a. Solder mask expansion or oversize value
   b. Thermal relief dimensions relative to pad size
2) Manufacturing:
   a. Stencil aperture size
   b. Stencil thickness

Additional Considerations

- Try to be consistent within a design layout using Cu-D or Msk-D pads, avoid mixing both.
- Many suppliers are now supplying recommended footprint dimensions for Cu-D and Msk-D designs. You may have to maintain both in the system library and use them accordingly.
- Telling your stencil fabricator to globally reduce aperture size by a percentage may produce undesired results. Take control, review the fabrication data yourself and edit to improve first run success.
- Lead-free solder doesn't wet and flow as well as tin/lead solder did. This normally undesirable attribute may be a benefit for Msk-D pads since the solder doesn't flow away from where it is printed as much during reflow, keeping the volume at the termination. **SMT007**

Ken Horky is a process engineer at Peterson Manufacturing.

2018 Programs

February 24–March 1 — San Diego, CA, USA
IPC APEX EXPO 2018

March 1–2 — San Diego, CA, USA
The Pb-Free Electronics Risk Management (PERM) Council Meeting No. 35
IPC APEX EXPO

March 20 — Tempe (Phoenix), AZ, USA
IPC Day
Complimentary event, network and learn more about IPC

March 20–21 — Tempe (Phoenix), AZ, USA
IPC Technical Education
Day One: EMI Control-Grounding, Power Distribution, Board Stack-up and More
Day Two: Practices to Produce a More Manufacturable Board and The Complexities of Fine Pitch BGA Design

April 10 — Boston, MA, USA
IPC Day
Complimentary event, network and learn more about IPC

April 10–11 — Boston, MA, USA
IPC Technical Education
Day One: IPC Technical Education — PCB Fabrication Basics: Process and Specification
Day Two: IPC Technical Education — Advanced Troubleshooting

April 16–17 — Ingolstadt, Germany
IPC Europe Technical Education
in English

April 18–19 — Ingolstadt, Germany
IPC Europe Technical Education
in German

April 24 — San Jose, CA, USA
IPC Day
Complimentary event, network and learn more about IPC

April 24–25 — San Jose, CA, USA
IPC Technical Education
Day One: IPC Technical Education — SMT Design for Manufacturing: Principles and Practice, Problems and Promises in a Lead Free World
Day Two: IPC Technical Education — BGA & BTC Design and Manufacturing Challenges with Emphasis on Reflow Profiling, Backward Compatibility and Head on Pillow

May 2 — San Diego, CA, USA
IPC Technical Education — PCB Layout — Place and Route
In conjunction with Del Mar Electronics and Manufacturing Show

May 8 — Milwaukee, WI, USA
IPC Technical Education
Morning: Real World Challenges and how IPC-HDBK-630: (Guidelines for Design, Manufacture, Inspection and Testing of Electronic Enclosures) has Helped
Afternoon: IPC/WHMA-A-620 CABLE & HARNESS DOCUMENTS: The Evolution of IPC's Cable and Harness Documents – A Brief History
In conjunction with Electrical Wire Processing Technology Expo

May 15–17 — Linthicum (Baltimore), MD, USA
IPC High Reliability Forum

May 21–23 — Washington, DC, USA
IMPACT Washington, D.C.
An executive-level, members-only event

June 4–5 — Nuremberg, Germany
Automotive Electronics Reliability Forum

June 5–6 — Glasgo, UK
IPC PERM International Meeting No. 36

September 13 — Des Plaines, IL, USA
IPC E-Textiles 2018

October 13–19 — Rosemont, IL, USA
IPC Fall Standards Development Committee Meetings
co-located with SMTA International

November 13–15 — Schaumburg (Chicago), IL, USA
IPC/SMTA High-Reliability Cleaning and Conformal Coating Conference

WISDOM WEDNESDAY WEBINARS — Exclusive for Members

March 14	April 25	June 13	July 25	September 12	October 24	December 12
March 28	May 9	June 27	August 8	September 26	November 14	
April 11	May 23	July 11	August 22	October 10	November 28	

For more information, **visit www.IPC.org/events**

Recent Highlights from SMT007.com

1 Start Your IPC APEX EXPO Show Experience Here ▶

Want a sneak peek into the upcoming events at IPC APEX EXPO 2018? This exclusive pre-show coverage publication from I-Connect007 is all about San Diego or bust!

2 Tempo Automation: Setting the Pace for Low-Volume, Quick-Turn Assembly ▶

Jesse Koenig, co-founder and VP of technology at PCB assembly company Tempo Automation, discusses with I-Connect007's Patty Goldman how they are making electronics development much easier and more seamless for customers.

3 IPC Study: Salary Budgets are Rising ▶

Average growth in salary budgets in 2017 and 2018 for the 49 contract electronics manufacturers and OEMs that contributed data to the study was a full percentage point higher than average pay increases in both years, indicating an expanding workforce.

4 SMTC Appoints Bob Miller as VP for Customer Acquisition ▶

Bob Miller, the newly appointed Vice President for Customer Acquisition at EMS firm SMTC Corp., has over 28 years' experience across a variety of industries, including the aerospace and defense, industrial and medical market segments.

5 7 Simple Ways to Motivate Your Electronics Manufacturing Staff ▶

Your manufacturing staff are the backbone of your electronics manufacturing organization. They are the ones showing up day in. day out to build products for your customers. So, keeping them motivated and engaged should be a priority, right? But too often during peak production periods, surmounting pressure can lead to staff feeling overworked, demoralized, and underappreciated.

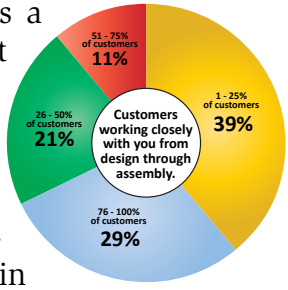
6 Cemtrex Inks Strategic Partnership with Smartglasses Maker Lucyd ▶

Cemtrex Advanced Technologies (CAT), a subsidiary of Cemtrex Inc., has announced that its CemtrexVR division has entered into a strategic partnership to develop augmented reality (AR) solutions with smartglass manufacturer Lucyd.

7 Libra Industries' Mentor Facility Renews ISO Certifications ▶

Libra Industries, a privately held electronics manufacturing services (EMS) provider, is pleased to announce that its Mentor facility has passed the recertification audits for its ISO 9001:2008 and ISO 13485:2012 certifications.

8 The Importance of Feedback in the Electronics Assembly Supply Chain ▶



Any customer feedback is a good feedback, whether it is good or bad, because it often pushes the supplier or manufacturer to improve. However, the problem in the electronics assembly supply chain is that customers often do not give feedback, unless it is negative.

9 Venture to Strengthen US Presence with Property Acquisition ▶

Upon completion of the proposed acquisition, the property will further augment Venture Corp. Ltd's cluster of excellence in the US, as well as strengthen its presence and image in the country.

10 MacroFab Expands Manufacturing Capacity, Sets Up Mexico Facility ▶

MacroFab Inc. has expanded its production manufacturing capacity and built its first international factory in Tijuana, Mexico.

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

smt007 pcb007 pcb design007

SALESPERSON WANTED · MAINLAND SOUTH CHINA

Work where you live!

The I-Connect007 China team is seeking an experienced salesperson to generate and manage a revenue stream for our Chinese publications.

Key Responsibilities include:

- Sell advertising contracts for monthly magazine
- Develop and cultivate new business
- Keep timely and accurate records
- Generate and follow up on all leads
- Manage contract renewals
- Account management: work with local and international team to provide customer support
- Phone and email communications with prospects
- Occasional travel

Qualifications

Successful candidates should possess a university degree or equivalent, experience with managing and cultivating leads, projecting, tracking and reporting revenue. We are looking for positive, high-energy candidates who work well in a self-managed, team-based, virtual environment.

Compensation

This is a base salary-plus-commission position. Compensation commensurate with experience.

Requirements

- Must be located in China Mainland, South China area preferred
- Good command of Chinese language, proficient with English speaking and writing
- Able to follow established systems and learn quickly
- Able to maintain professional external and internal relationships reflecting the company's core values
- 2-5 years' sales experience
- Experience with Microsoft Office products
- Must be highly motivated and target-driven with a proven track record for meeting quotas
- Good prioritizing, time management and organizational skills
- Create and deliver proposals tailored to each prospect's needs
- Experience in the electronics industry desirable

QUALIFIED CANDIDATES: CLICK HERE TO APPLY

I-Connect007
GOOD FOR THE INDUSTRY

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pcb007中国 每周通讯 WEEKLY NEWSLETTER

WWW.ICONNECT007CHINA.COM

Career Opportunities

MacDermid Enthone
INDUSTRIAL SOLUTIONS

Account Manager, North East

Do you have what it takes? MacDermid Enthone Electronics Solutions is a leading supplier of specialty chemicals, providing application-specific solutions and unsurpassed technical support.

The position of Account Manager will be responsible for selling MacDermid Enthone's chemical products. The position requires a proactive self-starter who can work closely and independently with customers and sales management to ensure that customer expectations and company interests are served while helping to promote MacDermid Enthone's exclusive line of products.

- Develop a business plan and sales strategy that ensures attainment of company sales and profit goals
- Prepare action plans for sales leads and prospects
- Initiate and coordinate action plans to penetrate new customers and markets
- Create and conduct proposal presentations and RFQ responses
- Possess the ability to calm a situation with customers, initiate a step-by-step plan, and involve other technical help quickly to find resolution

Hiring Profile

- Bachelor's Degree or 5-7 years' job-related experience
- Strong understanding of chemistry and chemical interaction within PCB manufacturing
- Verifiable sales success in large complex sales situations
- Desire to work in a performance driven environment
- Excellent oral and written communication skills
- Decision making skills and the ability to multitask

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KYZEN
Where Science and Care Converge.

KYZEN Regional Manager – Midwest Region

General Summary: KYZEN is seeking a Regional Manager to join our sales team in the Midwest. This position is ideally suited for an individual that is self-motivated, hard-working and has a "whatever it takes," positive attitude, especially with customers. Being mechanically inclined is a plus. KYZEN will provide on-going, in-the-field training to help you succeed.

CORE FUNCTIONS:

- Collaborates with the Americas Manager in establishing and recommending the realistic sales goals for territory
- Manages the assigned geographic sales area to maximize sales revenues and meet corporate objectives
- Develops sales strategies to improve market share in all product lines (Electronics and Industrial)
- Ensures consistent, profitable growth in sales revenues through planning, deployment and management of distributors and sales reps as well as continued direct support for customers and prospects processes

REPORTING:

- Reports directly to Americas Manager

QUALIFICATIONS:

- A minimum of seven years related experience or training in the manufacturing sector or the equivalent combination of formal education and experience
- Excellent oral and written communication skills
- Working knowledge of Microsoft Office Suite
- Mechanically inclined a plus
- Valid driver's license
- Travel within the region up to 75% of the time with occasional travel outside the region

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Career Opportunities

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, tradeshow, 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

American Standard Circuits
Creative Innovations In Flex, Digital & Microwave Circuits

Front-End CAM Operators

Chicago-based PCB fabricator, American Standard Circuits, is currently seeking front-end CAM operators to join their team. Desired applicant will have three years of CAM experience.

The candidate should also possess:

- Expertise in Valor/Genesis CAD/CAM software and PCB process
- Ability to process DRC/DFMs
- Excellent customer/people skills
- Ability to be a self-starter
- Ability to read prints and specifications

American Standard Circuits is one of the most diverse independent printed circuit board fabricators in the country today, building PCBs of all technologies, including epoxy MLBs, flex and rigid-flex, RF and metal backed.

To learn more about this position, please send your information to American Standard Circuits.

apply now

Career Opportunities

MacDermid Enthone
INDUSTRIAL SOLUTIONS

Technical Service Rep, North East

Do you have what it takes? MacDermid Enthone Electronics Solutions is a leading supplier of specialty chemicals, providing application-specific solutions and unsurpassed technical support.

The position of the Technical Service Rep will be responsible for day-to-day support for fabricators using MacDermid Enthone's chemical products. The position requires a proactive self-starter who can work closely and independently with customers, sales group members and management to ensure that customer expectations and company interests are served.

- Thoroughly understand the overall PCB business, and specifics in wet processing areas
- Prepare action plans for identification of root cause of customer process issues
- Provide feedback to management regarding performance
- Create and conduct customer technical presentations
- Develop technical strategy for customers
- Possess the ability to calm difficult situations with customers, initiate a step by step plan, and involve other technical help quickly to find resolution

Hiring Profile

- Bachelor's Degree or 5-7 years' job-related experience
- Strong understanding of chemistry and chemical interaction within PCB manufacturing
- Excellent written and oral communication skills
- Strong track record of navigating technically through complex organizations
- Extensive experience in all aspects of customer relationship management
- Willingness to travel

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orbotech

Electronics Expert Engineer

Orbotech is looking for an Electronics Expert Engineer to handle various hardware activities, including communication, data path processing, device interfaces and motion, as well as system supporting functions in a multi-disciplinary environment.

What Will Your Job Look Like?

- Providing cutting edge hardware solutions for challenging product line needs
- Developing board design and Logic in VHDL
- Defining and managing interfaces (software, algorithm, mechanics and electricity)
- Successfully integrating hardware with other product disciplines
- Supporting the product needs during and following release

What Do You Need to Succeed?

- BSc in electronics engineering
- At least 5 years of R&D experience in complex board design, mainly FPGA (communication interfaces, DDR controller, algorithm implementation)
- Experience in an Altera/Xilinx development environment
- Experience in ECAD design tools (DxDsigner, ModelSim) is an advantage
- Knowledge in laser interfaces, RF and analog is an advantage

Who We Are

Virtually every electronic device in the world is produced using Orbotech systems. For over 30 years, Orbotech has been a market leader in developing cutting edge inspection, test, repair, and production solutions for the manufacture of the world's most sophisticated consumer and industrial electronics.

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Career Opportunities

Printed Circuits

THE FUTURE OF RIGID FLEX CIRCUITRY

Sales Administrator

Purpose:
To assist the Sales Department in entering and tracking customer orders, supporting sales and marketing functions, and growing Printed Circuits customer base and sales.

Nature of Duties/Responsibilities:
- Provide point of contact for customers' quotes and orders
- Enter purchase orders
- Check orders for accuracy and completion
- Resolve order errors and inaccuracies
- Handle customer emails and phone calls
- Track and expedite customer requests and inquiries
- Work with customers to resolve outstanding questions and/or issues
- Report on open orders
- Keep customer contact database current
- Work with Engineering and Quality Assurance to meet customer expectations
- Complete other sales and/or marketing tasks as required

Education and Experience:
- At least 2 years of previous customer service center experience
- Ability to work with Microsoft (MS) Office, with focus on demonstrated working knowledge of MS Excel and Word
- Ability to work well in time-sensitive situations where customer satisfaction is the goal
- Ability to apply creative problem-solving techniques to situations using sound business judgment
- Excellent verbal and written communication skills
- Ability to multi-task in an effective, timely and professional manner
- Proven ability to apply attention to detail, role-related accuracy and task follow-through
- Willingness to learn new software products such as ACT!
- Bachelor's degree a plus

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saki

The Future in Focus

Field Application Engineer

Saki America Inc., headquartered in Fremont, CA, a leader in automated inspection equipment, seeks two full-time Field Application Engineers (FAE), one in the Fremont headquarters and the other for the Eastern and Southern United States.

The FAE will support the VP of Sales and Service for North America in equipment installation, training, maintenance, and other services at field locations. The FAE will provide technical/customer support and maintain positive relationships with existing and future customers.

Strong analytic abilities and problem-solving skills are a must in order to understand customer applications and troubleshoot issues. The FAE will perform demos and presentations for customers and agents as well as assisting in trade show activities. Candidate must have a minimum of a two-year technical degree, experience in AOI, SPI, and X-ray inspection, and strong verbal and written communication skills. The position requires the ability to travel about three weeks per month. Must be a US citizen and be able to lift up to 40 lbs.

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Career Opportunities

Altium

Business Development Representative at Altium

New Logo Business Development representatives are highly motivated and hardworking with an upbeat can-do attitude. They work with our New Logo Sales Team to displace our competition in accounts by offering Altium's unified PCB development tools within a defined region.

The New Logo Developer's (NLD) main responsibilities will be qualifying leads and prospecting into competitive lists, searching the web, and utilizing internal sales tools (Inside View, LinkedIn, Marketo, SalesForce) to uncover and work with opportunities for the New Logo Closer to close. They are expected to meet or exceed monthly, quarterly & annual quota.

Responsibilities:

- Develop lead opportunities by collecting information that includes business pains/needs, timelines, authority and project teams, budget, competitive information, etc.
- Aggressively drive daily prospecting calls to build pipeline of prospective clients and occasionally closing smaller deals
- Develop relationships with key partners in their territory to identify new business opportunities
- Plan and prioritize personal sales activities in conjunction with the New Logo Closer, with the goal of achieving sales targets
- Work alongside inside sales teams on specialized projects such as call-out campaigns, promo drives and webinar fulfillment
- Once trained, maintain an in-depth knowledge of Altium products and technologies, competitive products, and industry trends.

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CHEMCUT

BOUNDLESS INNOVATION | UNBEATABLE PRECISION

Field Service Technician

Chemcut, a leading manufacturer of wet-processing equipment for the manufacture of printed circuit boards for more than 60 years, is seeking a high-quality field service technician. This position will require extensive travel, including overseas.

Job responsibilities include:

- Installing and testing Chemcut equipment at the customer's location
- Training customers for proper operation and maintenance
- Providing technical support for problems by diagnosing and repairing mechanical and electrical malfunctions
- Filling out and submitting service call paperwork completely, accurately and in a timely fashion
- Preparing quotes to modify, rebuild, and/or repair Chemcut equipment

Requirements:

- Associates degree or trade school degree, or four years equivalent HVAC/industrial equipment technical experience
- Strong mechanical aptitude and electrical knowledge, along with the ability to troubleshoot PLC control
- Experience with single and three-phase power, low-voltage control circuits and knowledge of AC and DC drives are desirable extra skills

To apply for this position, please apply to Mike Burke, or call 814-272-2800.

apply now

Career Opportunities

Electronics Team Leader

Orbotech is seeking an Electronics Team Leader to join our electronics team, which develops multi-disciplinary systems, including vision/laser, image processing, and control and automation missions.

What Will Your Job Look Like?

- Lead a team of electronics engineers in a multi-disciplinary environment
- Lead electronic activities from requirement phase to development, integration and transfer, to production
- Be the focal point for other disciplines and projects managers
- Maintain and improve existing electronics platforms

What Do You Need to Succeed?

- BSc/MSc in electronic engineering/ computer science from a well-recognized university
- 5+ years' experience in digital board design, high-speed links, computing embedded systems, and HW/SW integration
- 2-3 years' experience in leading a team of engineers
- Solid skills in complex FPGA design with multi-modules
- Solid skills in high-speed board design, DDR3/4, PCIE, USB, IO, and optic links
- Ability to design and execute end-to-end solutions

Who We Are

Virtually every electronic device in the world is produced using Orbotech systems. For over 30 years, Orbotech has been a market leader in developing cutting-edge inspection, test, repair, and production solutions for the manufacture of the world's most sophisticated consumer and industrial electronics.

apply now

Ventec Seeking U.S. Product Manager for tec-speed

Want to work for a globally successful and growing company and help drive that success? As a U.S.-based member of the product and sales team, your focus will be on Ventec's signal integrity materials, tec-speed, one of the most comprehensive range of products in high-speed/low-loss PCB material technology for high reliability and high-speed computing and storage applications. Combining your strong technical PCB manufacturing and design knowledge with commercial acumen, you will offer North American customers (OEMs, buyers, designers, reliability engineers and the people that liaise directly with the PCB manufacturers) advice and solutions for optimum performance, quality and cost.

Skills and abilities required:

- Technical background in PCB manufacturing/ design
- Solid understanding of signal integrity solutions
- Direct sales knowledge and skills
- Excellent oral and written communication skills in English
- Experience in making compelling presentations to small and large audiences
- Proven relationship building skills with partners and virtual teams

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

Please forward your resume to jpattie@ventec-usa.com and mention "U.S. Sales Manager—tec-speed" in the subject line.

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

ventec
INTERNATIONAL GROUP
騰輝電子

Technical Sales Engineer

Positions available in the Chicago area and California

Do you want to advance your career by joining a globally successful and growing world class CCL manufacturer and help drive that success? As a California-based member of the technical sales team, your focus will be on Ventec's core market segments: mil/aero, automotive and medical, offering a full range of high-reliability materials including polyimide, IMS and thermal management products.

Skills and abilities required:

- Drive & Tenacity!
- 7 to 10 years of experience in the PCB industry in engineering and/or manufacturing
- Detail-oriented approach to tasks
- Ability to manage tasks and set goals independently and as part of a team
- Knowledge of MS office products

Full product training will be provided. This is a fantastic opportunity to become part of a successful brand and a leading team with excellent benefits.

Please forward your resume to:

jpattie@ventec-usa.com and mention "Technical Sales Engineer - California Based or Chicago area" in the subject line.

apply now

Career Opportunities

Altium

Application Engineer

The application engineer is the first contact for our customers who have technical questions or issues with our product. We value our customers and wish to provide them with highest quality of technical support.

Key Responsibilities:

- Support customer base through a variety of mediums
- Log, troubleshoot, and provide overall escalation management and technical solutions
- Create various types of topic based content, such as online help, online user guides, video tutorials, knowledge base articles, quick start guides and more
- Distill complex technical information into actionable knowledge that users can understand and apply
- Continually develop and maintain product knowledge

Requirements:

- Understanding of EDA electronic design software, schematic capture and PCB layout software
- Bachelor's degree in electronics engineering or equivalent experience
- Sales engineering and/or support engineering experience
- Circuit simulation and/or signal integrity experience
- Understanding of ECAD/ MCAD market segments
- Understanding of micro controllers, SoC architecture and embedded systems market
- Database experience preferred (i.e., MySQL, PostgreSQL, Microsoft Access, SQL, Server, FileMaker, Oracle, Sybase, dBASE, Clipper, FoxPro) etc.
- Experience with PLM/PDM/MRP/ERP software (Program Lifecycle Management) preferred
- Salesforce experience a plus

Salary based upon experience. Comprehensive benefits package and 401k plan. Openings in USA, UK, and Germany.

For more information, contact Altium.

apply now

ACE
ACCURATE
CIRCUIT
ENGINEERING

PCB Process Planner

Accurate Circuit Engineering (ACE) is an ISO 9001:2000 certified manufacturer of high-quality PCB prototypes and low-volume production for companies who demand the highest quality in the shortest time possible. ACE is seeking a skilled individual to join our team as a PCB process planner.

Responsibilities will include:

- Planning job travelers based on job release, customer purchasing order, drawings and data files and file upon completion
- Contacting customer for any discrepancies found in data during planning and CAM stage
- Consulting with director of engineering regarding technical difficulties raised by particular jobs
- Informing production manager of special material requirements and quick-turn scheduling
- Generating job material requirement slip and verify with shear clerk materials availability
- Maintaining and updating customer revisions of specifications, drawings, etc.
- Acting as point of contact for customer technical inquiries

Candidate should have knowledge of PCB specifications and fabrication techniques. They should also possess good communication and interpersonal skills for interfacing with customers. Math and technical skills are a must as well as the ability to use office equipment including computers, printers, scanners, etc.

This position requires 3 years of experience in PCB planning and a high school level or higher education.

apply now

Career Opportunities

IPS INTEGRATED PROCESS SYSTEMS INCORPORATED

PCB Equipment Sales

World-class manufacturer of wet process equipment for the PCB and plating industries, Integrated Process Systems Inc. (IPS) is seeking qualified candidates to fill a position in equipment sales. Potential candidates should have:

- Process engineering knowledge in PCB manufacturing
- Outside sales background
- Residency on the West Coast to manage West Coast sales
- Knowledge of wet process equipment
- Sales experience with capital equipment (preferred)

Compensation will include a base salary plus commission, dependent upon experience.

more details

ACE ACCURATE CIRCUIT ENGINEERING

PCB Assembly Supervisor—full time
Accurate Circuit Engineering—Santa Ana, CA

Position Summary: Responsible for all assembly processes to ensure continued growth as directed by management.

Essential Job Functions:

- Create, implement, and supervise in-house manufacturing facility
- Recruit, hire, train, and supervise assembly floor personnel
- Extensive hands on experience with all aspects of PCB assembly
- Understanding of IPC-A-610 standards
- Research and acquire additional assembly resources
- Gather data on product shortages, lead times, price changes, etc.
- Coordinate the assembly activities with sales to ensure 100% on-time delivery
- Create, implement, and supervise daily quality processes to ensure 100% accuracy
- Document, monitor and review progress of the business unit
- Respond to internal and external customers in a timely manner
- Coordinate walk-through, site audits, etc.

Qualifications:

- Minimum 3 years as operations supervisor of electronics assembly house
- 5+ years' experience in the electronics industry
- Previous experience as a quality or operations supervisor preferred
- Ability to solve practical problems using pre-established guidelines
- Strong facility in Microsoft Office applications
- Excellent verbal and written communication skills
- Ability to work with people of diverse backgrounds
- Highly organized/excellent time management skills
- Ability to perform at the highest level in a fast-paced environment
- Valid California driver's license.

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Advanced Search

thepcblist

The best way to find a PCB fabricator, *anywhere*.

www.thepcblist.com

Career Opportunities

FPGA Design Expert

Orbotech is seeking a FPGA Design Expert to join our electronics team, which develops multi-disciplinary systems including vision/laser, image processing and electro-optics.

What Will Your Job Look Like?

- Lead image acquisition and processing activities in the team
- Engage in all aspects of FPGA design activity: requirement phase, coding, synthesizing, verification support and LAB bring up
- Participate in system definitions for current and next generation products
- Collaborate with other teams: SW, algorithm and QA

What Do You Need to Succeed?

- BSc/MSc in Electrical Engineering from a well-recognized university
- Extensive knowledge of VHDL
- 5+ years of FPGA development experience (requirement, architecture, RTL coding, simulation, synthesis, timing analysis, P&R, board level integration and verification)
- Experience in designing and implementing low-latency, high-throughput FPGA designs utilizing PCIe Gen2/3, Gigabit Ethernet, SERDES, DDR3/4
- Experience in complex FPGA such as Altera Stratix-II and Arria 5&10 devices
- Authoring documentation experience such as FPGA specifications and FPGA verification plans

Who We Are

Virtually every electronic device in the world is produced using Orbotech systems. For over 30 years, Orbotech has been a market leader in developing cutting-edge inspection, test, repair, and production solutions for the manufacture of the world's most sophisticated consumer and industrial electronics.

apply now

Arlon EMD, located in Rancho Cucamonga, California is currently interviewing candidates for **manufacturing** and **management positions.** All interested candidates should contact Arlon's HR department at 909-987-9533 or fax resumes to 866-812-5847.

Arlon is a major manufacturer of specialty high performance laminate and prepreg materials for use in a wide variety of PCB (printed circuit board) applications. Arlon specializes in thermoset resin technology including polyimide, high Tg multifunctional epoxy, and low loss thermoset laminate and prepreg systems. These resin systems are available on a variety of substrates, including woven glass and nonwoven aramid. Typical applications for these materials include advanced commercial and military electronics such as avionics, semiconductor testing, heat sink bonding, high density interconnect (HDI) and microvia PCBs (i.e., in mobile communication products).

Our facility employs state of the art production equipment engineered to provide cost-effective and flexible manufacturing capacity allowing us to respond quickly to customer requirements while meeting the most stringent quality and tolerance demands. Our manufacturing site is ISO 9001: 2008 registered, and through rigorous quality control practices and commitment to continual improvement, we are dedicated to meeting and exceeding our customer's requirements.

more details

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March 14–16, 2018
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Shanghai, China

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March 28, 2018
Monroeville, Pennsylvania, USA

MicroTech 2018 ▶
April 9–10, 2018
Egham, UK

NEPCON China 2018 ▶
April 24–26, 2018
Shanghai, China

Electronics in Harsh Environments Conference ▶
April 24–26, 2018
Amsterdam, The Netherlands

2018 SE Asia Technical Conference on Electronics Assembly ▶
May 8–10, 2018
Kuala Lumpur, Malaysia

PCB EXPO Thailand ▶
May 10–12, 2018
Bangkok, Thailand

Medical Electronics Symposium 2018 ▶
May 16–18, 2018
Dallas, Texas, USA

NEPCON South China 2018 ▶
August 28–30, 2018
Shenzhen, China

Additional Event Calendars

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