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UP Media Group

PRINTED CIRCUIT DESIGN & FAB

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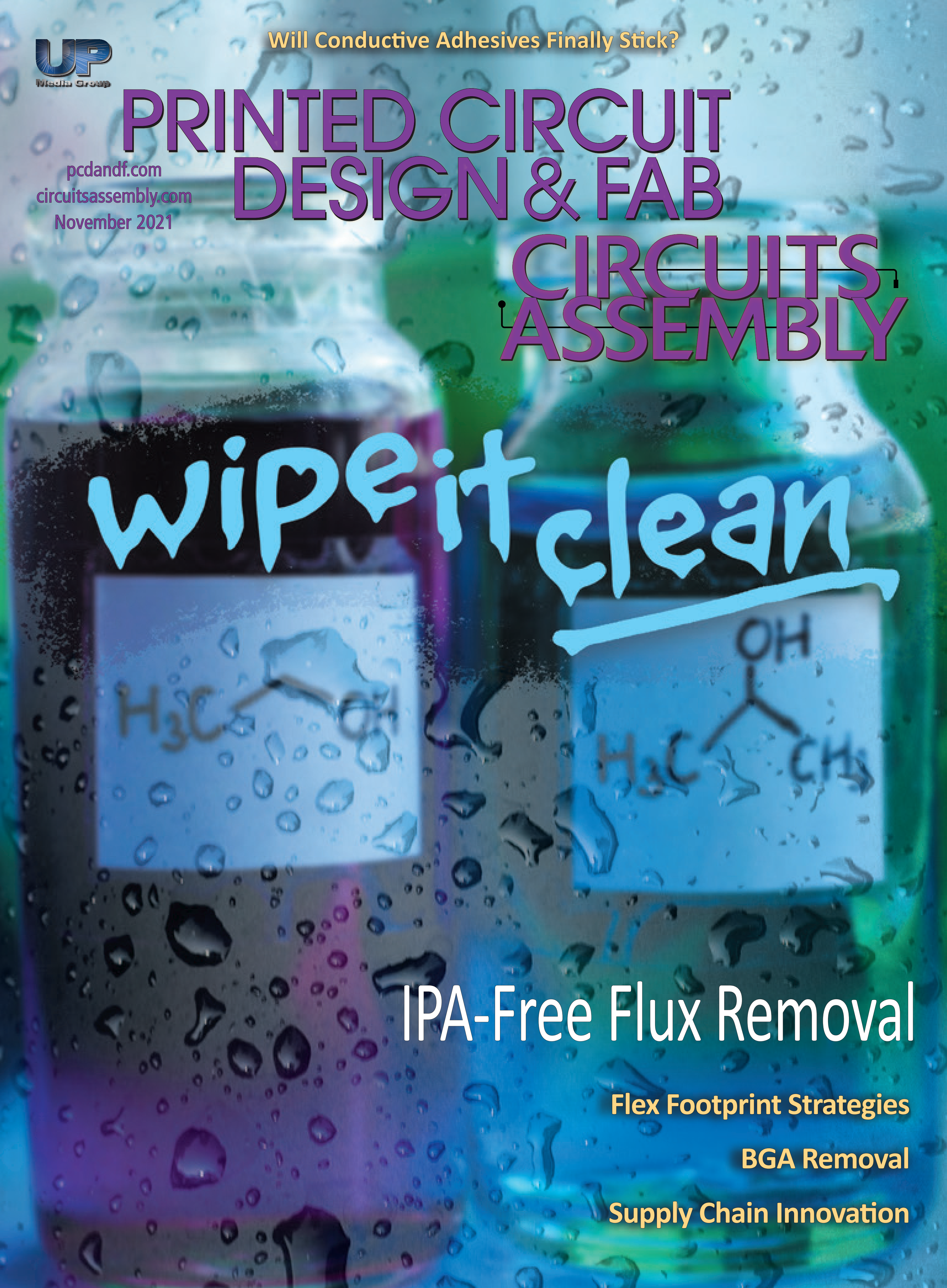

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TECH TALK

DEPARTMENTS

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ON PCB CHAT (pcbchat.com)

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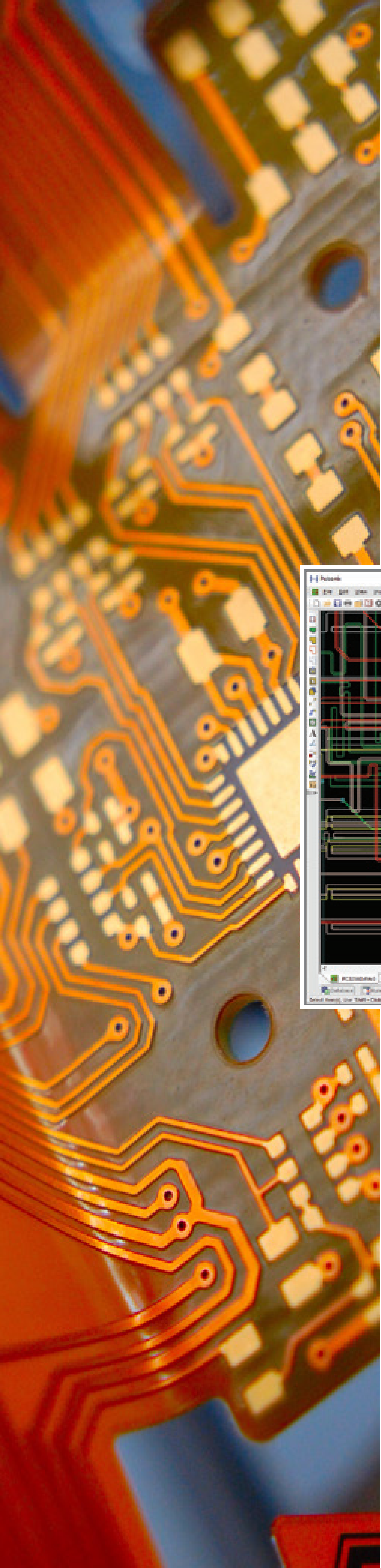


MIKE BUETOW
EDITOR-IN-CHIEF

PCEA Makes Its Move

I LEFT OFF last month on the subject of progress. "Are you making progress?" I asked. "In your career? In your life? And if not, do you plan to start?"

We at UP Media Group are planning to start right now. Last month, during our annual PCB West trade show, we announced the signing of a letter of intent to sell certain assets, including this magazine, to the Printed Circuit Engineering Association. More on that in a moment.

In its two short years, PCEA has already established itself as the leading association for printed circuit engineers. The leaders of the Designers Council formed it after IPC, its longtime benefactor, decided to go a different direction. The trade group has ties to SMTA and the European Institute for the PCB Community (EIPC), among others. And it is the certifying body for the PCE-EDU Printed Circuit Engineering Professional curriculum.

What, exactly, does this change mean? I'll answer three ways.

First, for PCEA, it acquires the PCB West and PCB East trade shows, PCD&F/CIRCUITS ASSEMBLY magazine; the PCB UPdate digital newsletter; the PCB Chat podcast; the PCB2Day workshops; and Printed Circuit University, the dedicated online training platform. It also includes all the databases and related websites, among other things. The move makes PCEA a significant player in terms of its capability to reach a huge audience of printed circuit designers and engineers, fabricators and assemblers, not to mention the massive trove of content it has for those audiences.

Next, for the UPMG staff, it means we are relocating to a new logo. Under terms of the acquisition, the staff will join PCEA. Of the folks you may know, Frances Stewart and Brooke Anglin will continue to handle sales and marketing, while my editorial colleague Chelsey Drysdale becomes chief content officer. As for me, I'll take the reins as the first president of PCEA.

The staff will report to the PCEA board, led by chairman Stephan Chavez. The PCEA board is made up of 12 industry volunteers, who set policy and oversee finances and operations for the organization.

Finally, for our audience, we see significant changes ahead. PCEA membership is free for individuals, and that offer will be extended to all our subscribers. With the backing of the PCEA board, a trove of industry engineers who include the leading experts in printed circuit engineering today, we expect to measurably increase both the amount of information available to you and the media it is available in. Whether written, verbal or visual; whether recorded or live; we expect to offer it all. Our technical content will be driven by users talking to and helping their colleagues.

What differentiates PCEA from other industry groups is it emphasizes the professional development of the individual engineer. As Chavez says, "The biggest feature PCEA brings to the industry is relationship building. Through our extensive network of engineers worldwide, we help industry professionals make informed decisions. With the acquisition of these industry-leading brands and databases, we have both the expertise and the reach to help any engineer, any time."

As for the timing, we expect the keys will be handed over in the next few months. And I would be remiss if I failed to mention what this means for Pete Waddell, founder and president of UPMG and PCB West. After 45 years in the printed circuit engineering industry, he is routing his last circuit. He said, "I've been a strong advocate for engineers to take charge of their own destinies. The PCEA was founded by folks I've known for decades to do just that. I can't think of a better group to carry on our traditions than the PCEA."

In my opinion, this deal marks major progress, for the individuals and companies involved, and the industry. Together, the opportunity now exists to help you, the readers, in your professional careers in a way never previously imagined. On behalf of the PCEA board and the UPMG staff, we are all thrilled at the prospect.

mbuetow@upmediagroup.com
@mikebuetow

P.S. See us at SMTAI in November!

P.P.S. I am sad to report the passing of Foster Gray, the brilliant Texas Instruments engineer who over his 41 years earned eight patents, 27 technical publications, and four published papers.

I worked with Foster at IPC, where he participated or led dozens of standards and round robin studies, and he was always prepared and always a gentleman. Our condolences to his family.

PCDF People

Insulectro named **Montserrat Barcelo** director of supply chain, replacing **Jason Shuppert,** who was promoted to vice president of operations.

Panasonic Industrial Devices named **Eriko Yamato** OEM business development manager. She previously was marketing manager for Oak-Mitsui and is a director of the PCEA.

Somacis named **Kent Balius** front-end engineering manager. He was formerly senior director of automation for TTM and Viasystems, and was an engineering manager at Sanmina.

PCDF Briefs

Altair announced the Altair Material Data Center consortium, designed to help make the Altair Material Data Center (AMDC) a materials information resource to support innovative product design and manufacturing.

Altair signed a channel partner agreement with **TrueInsight** to exclusively offer Altair's simulation, data analytics, and AI software solutions.

Ansys and **Autodesk** are collaborating on Autodesk Fusion 360's first third-party printed circuit board extension.

The previously announced sale of **APCT** to **Angeles Equity Partners** has been completed.

Atlantec installed an **ATG Luther & Maelzer** A9 flying probe.

Micross announced the launch of a 1Gb magnetoresistive RAM (MRAM) component, its highest-density part yet, and a device it hopes will prove the future of spintronics for high-reliability computing in harsh environments.

The **National Center for Manufacturing Sciences** published a report featuring analysis for digital product lifecycle management implementation, covering insight from years of collaborating with government and industry partners to determine a more cost-effective way to launch specific PLM processes.

Rockwell Automation and **Ansys** announced an integration of their respective software that gives automation and process engineers new ways to use simulation to improve the design, deployment and performance of industrial operations.

PCEA Agrees to Acquire Certain Assets of UP Media, Including PCB West

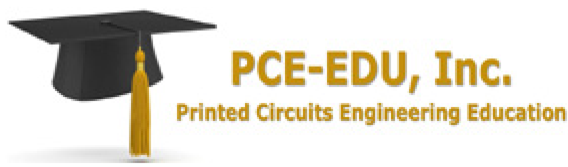
SANTA CLARA, CA – The Printed Circuit Engineering Association in October announced it has signed a letter of intent to acquire certain assets of UP Media Group Inc., including its signature publications and industry-leading trade shows. The deal establishes PCEA as the leading association for printed circuit engineers worldwide, with over 2.5 million engagements annually to printed circuit engineers, designers, fabricators and assemblers.

The acquisition includes the annual PCB West and PCB East trade shows; PCD&F/CIRCUITS ASSEMBLY magazine; the PCB UPdate digital newsletter; PCB Chat, the podcast series; the PCB2Day workshops; and Printed Circuit University, the dedicated online training platform.

Under terms of the acquisition, key UP Media Group staff will join PCEA, including Mike Buetow, who becomes president; Frances Stewart, who becomes vice president, sales and marketing; Chelsey Drysdale, who becomes chief content officer; and Brooke Anglin, senior sales associate.

The staff joining PCEA will report to the PCEA board, led by chairman Stephan Chavez. The PCEA board is made up of 12 industry volunteers, who set policy and oversee finances and operations for the organization.

"This acquisition came about after months of discussion between PCEA and UPMG," said Mike Buetow, vice president, UP Media Group. "We recognized that the goals and strengths of the respective organizations truly complemented each other, and there would be direct synergy to merging our efforts to better the industry."



"The biggest feature PCEA brings to the industry is relationship building," said Chavez. "Through our extensive network of engineers worldwide, we help industry professionals make informed decisions. With the acquisition of these industry-leading brands and databases, we have both the expertise and the reach to help any engineer, any time."

"After 45 years in the printed circuit engineering industry, it's time to boot down my machine," said Pete Waddell, founder and president, UPMG. "Throughout my career as a designer, magazine editor and trade show producer, I've been a strong advocate for engineers to take charge of their own destinies. The PCEA was founded by folks I've known for decades to do just that. I can't think of a better group to carry on the traditions of PCD&F/CIRCUITS ASSEMBLY, PCB East and PCB West than the PCEA."

A final closing date for the asset transfer is pending but expected to take place on or about Jan. 1, 2022. (MB)

Summit Interconnect Changes Hands

NEW YORK – New-York based private investment firm Lindsay Goldberg has acquired Summit Interconnect for an undisclosed sum in a deal closed Sept. 22. Summit, the second-largest printed circuit fabricator in the US, was previously owned by HCI Equity Partners, a private equity firm.

Summit is a leader in quickturn manufacturing of advanced technology printed circuit boards, primarily for aerospace, defense and other commercial sectors. The company has facilities in California, Illinois and Toronto. The Anaheim, CA-based company saw revenues grow 229% from 2017 to 2020.

Starting in 2016, HCI partnered with industry veteran Shane Whiteside to execute an organic growth and acquisition strategy for Summit in the US printed cir-

In the face of intensifying competition, **TPCA** says Taiwanese companies must leverage their core strengths to develop advanced PCB processes, materials and equipment to build the competitive advantage of the country's PCB supply chain.

Zuken has formed a new R&D unit in Japan with its Vitech unit to expedite efforts to develop application software and utilities linked to the Genesys modeling tool.

CA People

Enics appointed **Michael Cappello** chief business officer.

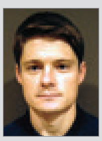
Infinite Electronics appointed **Matthias Norweg** senior vice president of corporate development. He has 20 years' experience in corporate development, investment banking and venture capital.

Keytronic named **Dan Coada** director of engineering.

Nordson named **Mark Norris** general manager, Electronic Production Systems Asia. He has been in equipment sales and marketing for more than 30 years with Camelot, Universal Instruments and Nordson.

Pride Industries appointed **Tim Young** senior director of talent acquisition. He previously was a recruitment director for Ross Stores and AutoZone.

SMTA announced **Mohamed El Amine Belhadi** of Auburn University as recipient of the 2021 JoAnn Stromberg Student Leader Scholarship, and **Yi Zhou,** a graduate student at Georgia Tech, as the 2021 Charles Hutchins Educational Grant winner. STI Electronics president/CEO **David Raby** received the SMTA Founder's Award.



SigmaTron promoted **Jim Barnes** to president. He supersedes Gary Fairhead, who remains chairman and CEO.

Thermaltronics USA hired **Ed Zamborsky** as regional and technical support manager. He spent the past 32 years with OK International in product and sales management.

ViTrox appointed **Joshua Glover** technical support engineer in the US. Glover has 15 years' experience in solder paste inspection, AOI and AXI.

cuit board industry. Since the initial investment, HCI and Whiteside completed four strategic add-on acquisitions and grew revenue in excess of 500%, while growing employee count by over 650.

In a statement, Shane Whiteside, president and CEO, Summit, said, "I decided to partner with the HCI team because I trusted they would be an excellent long-term business partner. Their unwavering commitment to our shared vision, strong business acumen and excellence in M&A execution helped accelerate our creation of a preeminent, advanced technology PCB manufacturer. I am very proud of what we have accomplished together."

Lindsay Goldberg also has significant position in the electronics manufacturing services industry, as owner of Creation Technologies, a CIRCUITS ASSEMBLY Top 50 EMS firm.

Doug McCormick, HCI's managing partner, commented, "We are honored to have had the opportunity to work with the Summit team over the past five years. They have delivered great value for our investors and built a better business with a better value proposition for key stakeholders, customers and employees alike. We wish them well in the next chapter of their growth under new ownership." (MB)

Tempo Automation to Go Public, Acquire Whizz and Advanced Circuits

SAN FRANCISCO – Tempo Automation on Oct. 14 announced a definitive merger agreement with ACE Convergence Acquisition Corp., a special-purpose acquisition company. Upon closing, expected in the first quarter of 2022, the combined operating entity will be renamed Tempo Automation Holdings and shares of its common stock are expected to trade on the Nasdaq under the ticker symbol TMPO.

The merged company will have estimated pro forma full year 2021 revenues of approximately $146 million.

The companies estimate post-transaction equity value of approximately $919 million based on current assumptions, with up to $391 million in gross cash proceeds to the company, consisting of $230 million from cash in trust by ACE and $161 million from financing from other investors. The majority of the cash proceeds will be used to complete acquisitions of Advanced Circuits and Whizz Systems.

Advanced Circuits is a quickturn PCB fabricator with annual revenues of about $90 million. Additionally, Tempo has entered into a definitive agreement to acquire all of the outstanding equity interests of Whizz Systems, a privately held EMS company based in San Jose and with additional manufacturing in Malaysia. The moves are expected to make Tempo more vertically integrated.

Upon closing, the combined company will be led by the Tempo management team, including president and chief executive Joy Weiss and chief financial officer Ryan Benton. (MB)

Exceet to Sell GS Swiss PCB

GREVENMACHER, LUXEMBOURG – Exceet Group signed a contract to sell GS Swiss PCB for approximately CHF 105 million (US$113.2 million). The company manufactures PCBs for the medical technology and aerospace sectors.

The completion of the transaction is not subject to any conditions and is expected to occur as of Dec. 31.

Exceet is expected to have a net cash position after transaction costs of about €110 million (US$127.2 million) after completion of the transaction.

GS Swiss PCB generated revenues of €36 million and operating profit of €9.5 million in fiscal 2021. (CD)

Printed Circuit Engineering Professional

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Supply Chain to Get 'Early Warning System'

WASHINGTON – The US Department of Commerce is establishing an early alert system to detect supply chain shortages in the semiconductor industry, according to reports.

The Microelectronics Early Alert System will consolidate information from producers and manufacturers, with the goal of minimizing disruptions without firms disclosing confidential information to competitors.

The new alert system is part of President Biden's program to strengthen supply chains. The 100-day supply chain review ordered by Biden in February highlighted the delicate global nature of the semiconductor supply chain. (CD)

Celestica to Buy PCI Ltd. in $300M Deal

TORONTO – Celestica will buy Singapore-based PCI Ltd., a design, engineering and manufacturing solutions provider, for $306 million. The deal is expected to close in the mid-fourth quarter of 2021, subject to necessary approvals.

The acquisition will expand Celestica's capabilities in key markets and strengthen geographic positioning. PCI has five manufacturing and design facilities across Asia.

The transaction price represents an adjusted EBITDA multiple of less than 7x (pre-anticipated synergies). Celestica expects the deal to be accretive to non-IFRS adjusted EPS in the first year.

"PCI is expected to generate about $325 million of annual revenue in 2021 with low double-digit adjusted EBITDA margins and strong cash flows," said Rob Mionis, CEO, Celestica.

Celestica reiterated its third quarter guidance for revenue in the range of $1.4 billion to $1.55 billion. (MB)

Apple, Zestron to Lead IPC Standard Effort for 'Green' Cleaners

BANNOCKBURN, IL – Apple is leading a host of companies developing a standard to define criteria for what constitutes a green cleaner for electronics manufacturing. IPC-1402, *Standard for Green Cleaners Used in Electronics Manufacturing* will specifically apply to cleaners used in the manufacture of electronic assemblies, components and materials, including direct use chemicals to clean components, casings, and materials or to clean manufacturing machines during operation and maintenance.

"The standard will document the rigorous set of criteria for preferred cleaners and incorporates industrial hygiene requirements. The application of IPC-1402 will allow important health and safety requirements to be added to engineering drawings needed for product assembly," said Matt Kelly, chief technologist, IPC.

The subcommittee is cochaired by Apple and Zestron, and includes representatives from more than 20 international companies and government authorities.

"People come first in everything we do, and we're proud to lead the industry in the responsible use of cleaners," said Kathleen Shaver, director of environmental and supply chain innovation, Apple. "We are glad to be working with partners on this new standard, which will help accelerate the adoption of safer materials and improve cleaning practices across industries."

IPC-1402 is expected to be available in February 2022. (CD)

CA Briefs

Continental named **Viscom** Supplier of the Year 2020.

Creation Technologies completed its acquisition of **IEC Electronics.**

The European Commission will put forward a European Chips Act, along with dedicated funds from a centrally managed program to boost research, development and manufacturing of microprocessors.

FC Group Invest has acquired UK-based EMS firm **Prism Electronics**.

France president Emmanuel Macron plans a national investment of 30 billion euros in leading-edge technologies, with electronics cited as one of the five essential levers to secure the conditions for innovation.

Intervala opened a new 217,000 sq. ft. electronics manufacturing facility in Mt. Pleasant, PA.

Intuitive Machines chose **Tempo Automation** to build its flight- and space-rated PCB assemblies.

Handset OEM/ODM **Lava International** has filed for an IPO in India.

LG Electronics has overhauled its home appliance manufacturing facility in Changwon, South Gyeongsang Province, to become an "AI-based automation factory," where robots carry and assemble pieces to make home appliances.

Merck plans to invest more than 3 billion euros ($3.5 billion) through 2025 in its electronics business to capitalize on rising demand for semiconductor and display panel materials.

NEOTech purchased two **ViTrox** V810 S2 3D AXI machines for its Longmont, CO, facility.

Samsung Electronics is setting up a TV production plant in Karachi, Pakistan.

Samsung is delaying its 3nm chip technology until 2022. Its 2nm successor will arrive in 2025.

SIA released its annual *State of the Industry Report* examining the US semiconductor industry's current global position, as well as challenges to — and opportunities for — continued industry growth and innovation.

SVI Public Co. signed a definitive agreement to acquire 100% equity stake of **Tohoku Pioneer (Thailand)** for an undisclosed sum.

United Time Technology will invest RMB150 million ($23 million) to establish manufacturing facilities for a line of smart telecom devices in China.

Vanilla Electronics announced the acquisition of EMS company **Interconics.**

Terran Orbital will build an Industry 4.0 space vehicle manufacturing facility in Florida, featuring advanced additive manufacturing and PCB assembly lines.

The **US Partnership for Assured Electronics** won an $8.9 million award from the **US DoD Office of Industrial Policy's** Industrial Base Analysis and Sustainment Program to grow the **Defense Electronics Consortium** and expand its work on the Lead-Free Defense Electronics Project.

Yamaha Robotics Factory Automation appointed **Growskills Robotics** distributor in Portugal.

US MANUFACTURING INDICES	MAY	JUN.	JUL.	AUG.	SEP.
PMI	61.2	60.6	59.5	59.9	61.1
New orders	67.0	66.0	64.9	66.7	66.7
Production	58.5	60.8	58.4	60.0	59.4
Inventories	50.8	51.1	48.9	54.2	55.6
Customer inventories	28.0	30.8	25.0	30.2	31.7
Backlogs	70.6	64.5	65.0	68.2	64.8

Source: Institute for Supply Management, Oct. 1, 2021

KEY COMPONENTS	APR.	MAY	JUN.	JUL.	AUG.
Semiconductor equipment billings[1]	50.3%	53.1%	59.2%	49.8%[r]	37.6%[p]
Semiconductors[2]	21.8%	26.2%	29.2%	29.6%[r]	29.7%[p]
PCBs[3] (North America)	1.16	1.11	1.15	1.29	1.48
Computers/electronic products[4]	5.18	5.24	5.26	5.27[r]	5.27[p]

Sources: [1]SEMI, [2]SIA (3-month moving average growth), [3]IPC, [4]Census Bureau, [p]preliminary, [r]revised

STUCK IN PORT Trends in the US electronics equipment market (shipments only)	% CHANGE JUN.	JUL.	AUG.	YTD%
Computers and electronics products	-0.1	0.1	0.3	7.0
Computers	-0.4	1.1	0.8	3.1
Storage devices	-0.7	-3.7	-0.5	32.9
Other peripheral equipment	-6.8	5.9	-2.2	5.9
Nondefense communications equipment	0.8	0.1	0.7	10.5
Defense communications equipment	3.9	0.0	-2.5	4.1
A/V equipment	-12.9	10.3	-3.6	-3.1
Components[1]	0.0	2.0	-0.5	6.0
Nondefense search and navigation equipment	1.7	0.9	-0.8	2.4
Defense search and navigation equipment	0.4	1.1	-0.1	2.8
Medical, measurement and control	-0.3	-0.8	1.3	7.6

[r]Revised. *Preliminary. [1]Includes semiconductors. Seasonally adjusted.
Source: U.S. Department of Commerce Census Bureau, Oct. 4, 2021

Hot Takes

- **Taiwan's PCB sales** will reach an all-time high this year. (TPCA)
- **Spending on compute and storage infrastructure products** for cloud infrastructure, including dedicated and shared environments, decreased 2.4% year-over-year in the second quarter to $16.8 billion. (IDC)
- Growth in **electronic component sales** have stabilized in recent months following wide swings in growth expectations over the past 20 months. (ECIA)
- In 2020, **new car sales** were down approximately 15% year-over-year, driven by changing consumer needs around travel, job uncertainty, and factory closures during lockdowns. (IDTechEx)
- By 2022, with current trajectories and assuming no supply constraints, **electrification in the automotive sector** will demand an additional $7.4 billion worth of semiconductor material compared to a scenario without electrification. (IDTechEx)
- Eighty-eight percent of **electronics manufacturers** that responded to a recent survey have experienced increased lead times, and 31% saw production delays of eight weeks or more, due to the global component shortage. Some 58% of those companies expect the shortages to end in the second half of 2022 at the earliest. (IPC)
- **Total North American EMS orders** in August rose 28% year-over-year and 29% sequentially. Shipments for the month were down 3.2% compared to the month in 2020. Sequentially, shipments grew 17%. (IPC)
- **Semiconductor shortages** and the delayed packaging and testing of the chips will cause production of global light vehicles to drop by five million this year. (IHS Markit)
- **Prices for rare earth metals** have surged and will likely impact the prices of electronics for end-users in the coming months. (Nikkei Asia)
- **The AOI market** is projected to reach $1.66 billion by 2026, a CAGR of 21% from 2020 to 2026. (MarketsandMarkets)
- **Global shipments of traditional PCs,** inclusive of desktops, notebooks, and workstations, reached 86.7 million units during the third quarter, up 3.9% from the prior year. (IDC)
- **Taiwan's major notebook ODMs,** including Quanta Computer, Wistron, Compal Electronics and Inventec, are not expected to sustain regular peak-season shipment momentum in the second half of the year. (DigiTimes)
- The **global PC market** saw annual growth of 5% in the third quarter, with shipments of desktops and notebooks, including workstations, settling at 84.1 million units. (Canalys)
- **Electrically conductive adhesives** are predicted to increase their market share with the transition toward integrated and flexible electronics. (IDTechEx)
- **Notebook shipments** for 2021 will likely reach 240 million units, a 16.4% annual increase. (TrendForce)
- **Worldwide shipments of gaming PCs and monitors** are expected to grow at five-year compound annual rates (CAGRs) of 4.8% and 13.2%, respectively. (IDC)
- **Sales of printed circuit board and multichip module design software** rose 16.8% year-over-year to $284.4 million for the period ended Jun. 30. (ESD Alliance)
- The **global 5G technology market** is expected to reach $65.5 billion by 2026. (Research & Markets)
- While **DDR5 products** gradually enter mass production, NAND Flash stacking technology will advance past 200 layers. (TrendForce)

The Supply Chain Worked Great. Until It Didn't.

The current crisis was years in the making.

ONE OF THE BIGGEST current concerns for the economy, in virtually every country in the world, is the state of the global supply chain. Whether discussing the shortage of chip's impact on the auto industry or the shortage of paper goods (think toilet paper), all fingers point to a supply chain that is showing signs of fatigue.

To fully appreciate the situation we face, one needs to first look at how the supply chain got to this point.

Historically companies strived for a fully integrated manufacturing capability, so materials, parts, subassemblies, etc., were designed and controlled by the company that produced the end-product they were to be used in. As an example, an automaker would own the steel mill, glass-making facility, radio manufacturer, paint factory, etc., so virtually all parts that went into their automobiles were manufactured – controlled – by one company. Shortages, if and when they occasionally might occur, could be quickly rectified by moving resources around within the parent company to increase supply of needed items.

Beginning in the 1960s and '70s, this business model began to change. Many reasons include increased complexity of the components and subsystems needed to make an end-product, as well as the value-add management philosophy of focusing on being great at one thing, such as creating and marketing an automobile, while offloading the "distracting" details of making all the "commodity" parts needed to produce an automobile to others who in turn would focus on being great at making those parts. This growing trend was in many ways the birth of the supply chain as we now think of it: companies offloading aspects of manufacturing they were no longer interested in committing resources for to companies that could find economies-of-scale by selling to multiple companies and the increasing volume and margin. As most of the component and subassembly companies had been owned by one of their customers, most were located close to their major customers and, therefore, "local" businesses.

Globalization entered the picture during the 1980s and '90s, however. A combination of aging facilities requiring reinvestment and dramatically improved expertise and quality in new places, particularly Asia, where costs were relatively lower as well, led companies to invest where quality and volume could be produced far less expensively. Concurrently, major improvements were taking place in the shipping world. Container ships and air-shipping made long-distance global transportation almost as cheap as in-country trucking. Suppliers could now be as efficient delivering product, when needed, across the globe as they once were shipping across town. The supply chain became global. And during most of the past two decades, the global supply chain has been on a tear.

This evolving supply chain has benefited most of us. Economic growth was seen throughout the world, especially in lower-cost countries. Consumer satisfaction ramped as technology-rich product, as well as basic staples of life, became much cheaper and affordable. Time-to-market decreased as teams working together across the globe worked virtually 24/7 to develop, validate, produce and then deliver new products. With all these positives, why is the global supply chain showing such signs of fatigue?

Call it a perfect storm of politics and pandemic.

The political winds started four or five years ago when tariffs, a tool that seldom works, were implemented as a tough stance against those viewed as economic threats. The track record of taxing trade has in the past resulted in some historic events, most notably the Great Depression of the 1930s. The current round of tariffs has incentivized manufacturing to migrate to countries that are not charging tariffs at the expense of those that do. It seems naïve of politicians to think they can quickly undo a supply chain decades in the making without serious and significant repercussions. In a global supply chain, this disruption creates regional spot shortages, which, combined with the tariff itself, raise prices for some while making those not subject to the tariff that much more competitive.

While the global supply chain was adapting to tariffs, the world fell victim to a global pandemic. Covid-19 spread like wildfire across the globe. The initial moves made by many were to close facilities to contain spread, either because employees had contracted the disease or to prevent employees from contracting it. With capacity reduced, inventories started to shrink as available items were consumed. When supply decreases, especially with the potential of further spot plant closures, customers begin hoarding inventory, putting even more tension on supplies, leading to price inflation.

Put it all together and the global supply chain starts getting stretched. Any chain is only as strong as its weakest link, and some links across the globe are beginning to snap. But what to do?

Any time dynamic events wreak havoc on the status quo, the key response is to stay focused on what

continued on pg. 31

PETER BIGELOW is president and CEO of IMI Inc.; pbigelow@imipcb.com. His column appears monthly.

Coping with Supply Chain Disruptions: An EMS Owner's View

Extended lead times, fake parts, 300% price hikes: What could be next?

IT'S COMMONPLACE AMONG electronics manufacturing services companies to develop workarounds for problems that crop up quickly, or to think on our feet to find ways to deal with seemingly insurmountable obstacles. Worldwide supply chain disruptions are not unusual to the electronics design and assembly and design industry. The current situation is exceptional, however, and its causes wide-ranging, but of course we still must get the product built and shipped to the customer. That doesn't change.

The current shortage of parts came as no surprise: We saw the writing on the wall some four or five months ago. Anticipating problems is critical in this business. We secured large quantities of components that, for example, we knew were becoming very hard to find but also required for current and future customer builds. Indeed, some parts now have lead times of up to two years, such as certain types of FPGAs, microcontrollers, and other types of ICs. Unfortunately, this means larger-than-normal inventory on hand and at our partners' locations, which is contrary to our "just in time" operational model.

Parts scarcity leads to perhaps two of the most significant challenges for managing an EMS: the artificial inflation of parts cost and the rise of counterfeits, even at authorized resellers. Some suppliers are selling these parts for more than five times their normal price. It affects BoM costs and pricing back to the customers, which eventually proves disruptive for everyone's business model. We have leveraged our long-term relationships with specialized authorized component resellers/distributors, many of whom are able to find parts and also have methods to determine the legitimacy of those parts, which is critical in times like these. In some cases, we've found and rejected counterfeits, and the specialized resellers/distributors must procure a new batch. In the end, the customer gets good parts, but all the back-and-forth in some instances causes delays. There have been drastic changes over the past few months, and some projects we quoted end up with shortages by the time we receive the customer PO. I have never seen anything like it in all the years we've been in business. In summary, backlogs remain elevated, inventories short and lead times historically long.

It's fallout from the worldwide semiconductor shortage, as a lot of what we're missing are ICs. FPGAs are the biggest problem, followed by small microcontrollers, then specialized ICs such as power regulators, level translators and RF components. What's also interesting, in some cases, is the shortage of connectors, and specific types of wires for cables. Why this is so, we don't know, but the most critical issue is, again, the shortage of ICs.

Luckily, we have avoided delayed delivery penalties for missing contracted ship dates, and the key to that is instant communication with our customers. They know what's going on in the industry, and we inform customers immediately when we learn of delays due to supply-chain issues. We always let customers know early, so all are fully aware of the conditions and can inform their customers to plan accordingly.

It's a similar issue when quoting builds. Normally, a quote could be issued in a day, but now it may take five days because we must locate hard-to-find components and receive guarantees of availability. Also, returning and replacing counterfeit parts causes another time delay, and in many cases these delays are significant. Price fluctuations are a significant problem as well. In many cases, we do not pass them onto the customer, and sometimes we've already gone ahead and committed to a certain cost or price in flight, and it changes in the process; this is very impactful to our business, especially with large orders. As such, we're monitoring price fluctuations in real time and informing customers about price changes as best we can, but we are still at risk.

As an example, our defense business sometimes has a much longer quote-to-PO-issuance timeline. This can be a real problem, because we've issued quotes as early as the beginning of this year, for example, that don't get awarded for 90 to 120 days. In one case, we bid a project at the end of the first quarter, and it was awarded just under 90 days later. In addition, we're dealing with parts that are aged; some of these components were from the 1970s and '80s. Not only are they difficult to find, but in some cases we're experiencing an overnight 300% markup.

So, when we looked at the quotes back in March, for example, they were priced at X, and now they cost 300% more. This is an example of where we went back to the customer and asked for a price increase, knowing we risk the contract getting canceled. It's not a penalty per se, but it is lost revenue if they're not willing to accept the new price. In these extraordinary times, it all hinges on being dynamic, dealing with extreme ambiguity, while fostering a great network of partners to help navigate and resolve the challenges of supply and erratic component price fluctuations. Ultimately, if you don't secure the parts, and you can't ship the job, you don't make revenue. It's very challenging for EMS business operations right now, sometimes even daunting! ❑

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Component Footprint Differences between Rigid and Flex Circuits

Flexible printed circuits have unique requirements for footprints owing to the nature of their application.

HERE IS ANOTHER lesson I learned the hard way: taping out an FPC (flex printed circuit) using the usual components and finding it doesn't *really* work that way. Several things separate a rigid board from a flex. One of the main tenets behind the different design rules is reducing the risk of the circuit peeling up when it gets flexed. Even without continuous flexing, a flex circuit can be under tension where it is folded, twisted, spindled or mutilated.

Ah, but the flexible section is generally not where we install components. Normally, a stiffener covers part of the flex, and components are on the other side. Therefore, it is rigid, right? Not really. Most stiffeners used on flex circuits have a degree of flex to them. Flex stack-ups are intended to be as thin as possible; it's one of their advantages. Even stainless-steel versions have some give. Many are made of FR-4 or another layer of polyimide, not all that stout.

In short, this means we want something more like a Class 3 footprint in that the maximum size pad is preferred. More area gives it more bite on the surface. A typical rule for flex is to use a fillet to taper to the line width of the traces. Any abrupt angles are stress-risers and need to be avoided. Round things off rather than squaring them.

These flex circuits also require greater tolerance for add-on layers. Solder mask, coverlay, stiffeners and silkscreen fall under this umbrella. Let's break down each of these materials as they relate to the component footprint.

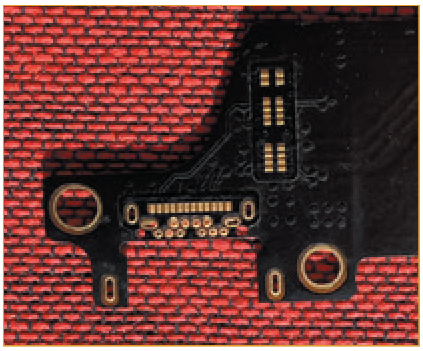

FIGURE 1. It's black over black, but the coverlay openings are visible in this close-up of an FPC with a USB-C connector footprint.

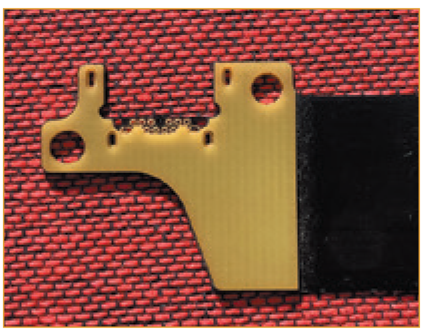

FIGURE 2. FPC from Figure 1, as seen from below. Note the numerous openings for the slots and large holes, while the pin pattern is a mass opening for this stiffener.

Solder mask. As you would expect, there is a specific material to call out for solder mask on a flex circuit. It bends without breaking, up to a point. We usually expand the solder mask by 0.1mm (or 50µm on each pad edge) for a rigid board. The happy place for an FPC solder mask opening is four times that, unless you choose laser-defined geometry. The result is that a row of pins is very likely to have gang relief instead of individual mask openings. Low-volume soldering helps prevent solder bridging.

Coverlay. Kapton is the popular trade name for this polyimide material. It is pre-cut with different methods, depending on accuracy and production quantity. Whether stamped with a die or milled with a rotating cutter, specific primitive shapes, mostly circles and rounded rectangles, work best for the openings. There are more options when a laser is involved, but the creativity it enables comes at a higher unit price. Photoimageable coverlay is a slightly less accurate possibility for the odd shapes that cannot be done using CNC.

A good coverlay has an organic appearance. If you're going with the crowd, the color you want is black (**FIGURE 1**). That has little to do with the component footprint, just a note that there are options to consider. The clearance is likely to be another 0.2mm beyond the already generous solder mask opening. Specific openings in the coverlay deserve a layer of their own in the PCB footprint.

Stiffeners. In most cases, the areas with a stiffener will have the coverlay end with a nominal overlap of the stiffener, although they are on opposite sides of the flex. A transition area where the edge of the stiffener, the coverlay and solder mask all meet is always staggered. The coverlay goes over the top of the solder mask to help it stay down. The stiffener underpins the whole transition area. This is a no-via and no-pad zone. This is one of those things that will stop a design from getting into fabrication, if not done correctly.

Many flex circuits are nothing more than a bespoke cable between two other printed circuit boards. They

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have connectors of some type, gold fingers, through-hole, surface mount or ZIF connectors with their interlocking pins. Each of these has a specific stiffener under it. That stiffener geometry should be added to the footprint for reuse.

Supported pads vs. non-supported pads. The FPC industry makes a distinction between pads that include a hole and pads that attach to the rest of the circuit only by a trace on the outer layer. The plated through-hole or microvia acts as an anchor that keeps the pad from lifting during high-temperature excursions such as soldering.

If the pad is hanging out by itself, it is in danger of delamination in those harsh assembly environments. In those cases, we like to add so-called spurs to the pad. These are also called tabs, flanges, fingers, anchors or whatever, but I think spurs is the most precise term. Get ready for some weird padstack shapes as they grow one or more extra stubs, er, spurs!

Silkscreen. Marking on FPCs can be hit or miss. I tend to miss the mark, even when being really conservative with text height, stroke width, and so on. No matter how far marking is placed from the part, the vendor will suggest moving it farther away. Forget about part outlines. Board-level marking may be all you can expect.

Most flexes are relatively simple from a design standpoint, so that's a plus. The easiest way to mark these types of circuits may be with a handheld rubber stamp and ink pad. Rigid-flex is a different animal, at least for the rigid area(s), but I recommend keeping it simple when it comes to marking an FPC.

Wrapping it up. With these limitations, the rigid footprints in your library may not be applicable. An alternative for each symbol is recommended to reduce the number of technical questions from the vendor once the board tapes out. Speaking of vendors, the ones that specialize in flex circuits really want to engage you early in the design cycle for numerous reasons. The stack-ups have more variables, and processes require more give and take.

And that's before accounting for the actual flexing, the ESD film, tear-stops, ground mesh and other esoteric attributes of the flex fabrication and assembly processes. Developing a specific library to go along with the unique design rules is a good first step toward success in the flexible circuit realm. □

Getting Up to Speed

Even our wildest predictions for new technologies like the IIoT could be too modest.

"ONE DAY THERE will be a telephone in every major city in the USA." This outrageous assertion, attributed to Alexander Graham Bell, illustrates the difficulty we face in trying to grasp the full potential of great opportunities. He also suggested – presumably later – that "the day is coming when telegraph wires will be laid onto houses just like water or gas – and friends converse with each other without leaving home."

And so it is, I'm sure, with the Internet of Things (IoT). It's just getting started. Of course, great claims have been made, particularly on the number of devices that will become connected. The IPv6 address space permits more connections than we can practically contemplate. But it's the types of applications and services, the capabilities we will gain by leveraging data from IoT devices, that will change the way we live and work in ways we cannot conceive right now.

Under the general heading of the IoT, the Industrial IoT (IIoT) has taken on a life of its own as commercial organizations realize the potential benefits. It's a key element of the fourth industrial revolution, the enabler for physical systems to become cyber physical systems.

IIoT applications are typically created to increase productivity: capturing the data that tell us why that batch, made at that time on that day, was faulty, or that tell us in advance when a machine needs attention to simplify maintenance and avoid stoppages.

There are potential benefits to be gained in all industrial activities, such as safety in the workplace. Protection for workers in dangerous areas, for example, can be improved, particularly those who must work alone or unsupervised. Groups of sensors working together, such as proximity sensors, motion sensors, environment sensors, even vital-signs sensors in wearable devices, can tell if workers are in the right place at the right time, if they have been hurt or knocked over by moving machinery, or perhaps received an electric shock.

The IIoT's evolution will also likely include more efficient implementation, particularly taking advantage of models such as community deployment that is ideal for companies with synergistic models or common business objectives to cooperate, share data easily, and split the costs of access to high-performance computing and analytics. Various service models are available too that let companies use software maintained by a cloud service provider, manage the software themselves as part of a platform agreement, or take advantage of the cloud provider's infrastructure while maintaining their own proprietary tools. This Infrastructure as a Service (IaaS) model gives users greater control over aspects such as data sovereignty and the ways in which workloads are handled, making it extremely popular. According to Gartner, the IaaS market grew over 40% in 2020, a phenomenal performance by any reckoning.

However virtualized our concept of the cloud may become, everything ultimately connects back to data centers that contain real equipment, doing real work. Whether a rented slice of a hyperscale installation, or a privately owned or shared enterprise-class data center, high performance and efficiency are of paramount importance. Power consumption and cooling challenges facing data center operators are well discussed. The battle to minimize energy losses begins as soon as the power enters the building and continues down to the molecular level in the fabric of the servers' circuit boards. This is the preserve of our industry, of course, and is precisely the challenge for which today's low-loss materials are being developed.

Every interaction between the computing system's transceivers has a signal loss component and hence a thermal overhead, however incremental each may be. At today's giga-transfer-per-second data rates, the effects accumulate quickly, and low-loss substrate materials are becoming increasingly critical to maintain energy efficiency, thermal management, and signal integrity in the relentless pursuit of ultimate performance and throughput. The fastest possible response is always needed, whether these are the latency-sensitive workloads that are being pushed toward increasingly fast-performing edge devices, or the big number-crunching and data-intensive AI applications that remain the preserve of the cloud.

Among the low-loss material technologies available, PTFE is the best we have today and likely to remain so for some time. No alternative I can see comes close right now. The relative lack of a dipole moment, due to PTFE's molecular structure, prevents signal energy from being absorbed and dissipated as heat. The most advanced ceramic-filled PTFE composites can achieve ultra-low dissipation factor, close to 0.002, combined with a precisely controlled dielectric constant and low CTE. PTFE also has near zero dielectric loss when used as cable insulator.

Although it's hard to see any technology that could challenge PTFE, Alexander Graham Bell's is not the only example that warns us against underestimating where our technologies might lead and the benefits they might deliver. We can never say "never" or stop working toward "better." ❑

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A Grand Announcement!

The PCEA is about to be reshaped in ways none could have imagined.

WHAT OTHER THAN a dynamic organization like the PCEA could decide it wants to establish a trade show footprint one month and then muster the creative talents of its executive staff to design a trade show booth to exhibit at DesignCon the next? Oh, and then exhibit at another major trade show like PCB West only a short time after? I'll tell you, the PCEA has a momentum the likes of which I and many others have not seen in this industry.

I do not use "momentum" lightly. Because like the shiny, spherical bob of a pendulum in a Newtonian mechanics experiment, the leadership of this organization seems to be able to swoop down from their rightward (positive) displacement, pass their zero position goal of achieved success and still have enough momentum to reach their leftward displacement, where they tend to set yet another, even loftier goal. The harmonic motion repeats but, unlike a pendulum, appears to *gain* energy rather than lose it to physical pseudo-forces.

I'm usually bad at metaphors, although I've (ab)-used a few in this space from time to time. As a graphic-minded career professional in an industry that still relies on "artwork" to create PCB hardware, it is sometimes difficult for me to describe things without using this metaphor shtick to make a point. But here I am again, exceeding the physical confines of my pendulum metaphor. The metaphor is inaccurate because, unlike a pendulum, which eventually loses its kinetic energy and stops, the PCEA is growing and gaining energy! As Mike Buetow notes in his column on pg. 6, PCEA has signed a letter of intent to purchase certain assets of UP Media Group. Talk about momentum – wow! This means the organization went from an idea hatched among a group of PCB industry friends and colleagues at a trade show to entering a deal to purchase a major trade show (and a magazine, and a newsletter, and an online university, and … you get the point) all in the span of less than two years. Even *Star Trek's* admirable chief engineer and miracle worker Montgomery "Scotty" Scott would be amazed at our leadership's ability to seemingly defy the laws of physics!

FIGURE 1. Chairman Steph Chavez (left) is joined by chairman emeritus Gary Ferrari (center) and vice chairman Mike Creeden.

KELLY DACK, CIT, CID+, is the communication officer for the Printed Circuit Engineering Association (PCEA). Read past columns or contact Dack at kelly.dack.pcea@gmail.com.

From the Chairman

by Stephen Chavez, MIT, CID+

I want to personally thank Kelly for his unique flare of capturing all the positive PCEA emotions over these past two years and putting them into colorful words in the success of this column, and for his professionalism and tireless efforts in taking this column to the heights where it is today. Outstanding job, Kelly!

Elsewhere in this issue is the big news of the day: PCEA is acquiring the assets of UP Media Group, including this publication. Words don't adequately express how excited we are at this prospect. Let me briefly explain what this means.

The PCEA board of directors is made up of 12 industry engineers. Just like you, we spend our days designing and building printed circuits. Our roles in the association are voluntary. We do this out of a passion for helping our colleagues.

The acquisition of these assets, which also include the PCB West and PCB East trade shows, among other properties, brings with it the first full-time staff for PCEA. The board can henceforth focus on the traditional roles of directors, including reviewing the strategic and operational issues we need to address and setting the goals for the organization. The board, in short, will set the strategic plan. The staff, for its part, will be responsible for the operations and executing that plan.

This puts each of the respective board members and the PCEA staff in roles where we can individually and as a unit reach our optimal effectiveness.

We expect to form a nominating committee for

future board members, so if you are interested, please drop me a line.

I will have much more to say on this as we go forward and complete the transaction and work toward fleshing out the strategic plan. Until then, feel free to reach out to me anytime.

I want to personally thank Kelly for his unique flare of capturing all the positive PCEA emotions over these past two years and putting them into colorful words in the success of this column, and for his professionalism and tireless efforts in taking this column to the heights where it is today. Outstanding job, Kelly!

Warmest regards,

Steph

FIGURE 2. At PCB West, PCEA members join attendees to celebrate the news.

Next Month

I am stepping down as communications officer on the PCEA board at the end of October, as the staff transitions into its new role. Still, readers can look forward to this column being an inspiring, direct information feed to us all regarding the plans and activities of the Printed Circuit Engineering Association. If you've noticed, Steph often makes a point in his writing to "highly recommend" participating in all things PCEA. I'd like to borrow his gesture here this once and highly recommend you tune into this column to keep up with the how the PCEA is continuing its momentum to collaborate, educate and inspire all of us in this organization and this industry!

Upcoming Events

Below is our list of upcoming events. Hope to see you at any of these!

- **SMTA International** *See us at booth 3006!*
  Nov. 1-4, 2021 | Minneapolis, MN
  www.smta.org/smtai/

- **Productronica**
  Nov. 16-19, 2021 | Munich, Germany
  https://productronica.com/index-2.html

- **PCB Carolina 2021** *See us here!*
  Nov. 10, 2021 | Raleigh, NC
  www.pcbcarolina.com

- **Altium Live 2022** *See us here!*
  Jan 26 – 28, 2022 | San Diego, CA
  altium.com/summit

- **IPC Apex Expo**
  Jan 22 – 27, 2022 | San Diego, CA
  ipcapexexpo.org

- **PCB East 2022** *See us here!*
  April 11 – 13, 2022 | Marlborough, MA
  www.pcbeast.com

Spread the Word

If you have a significant electronics industry event that you would like to announce, please send the details to pr@upmediagroup.com, and we will consider adding it to the list.

Refer to our column and the PCEA website to stay up to date with the upcoming industry events. If you have not yet joined the PCEA, visit our website (www.pce-a.org) to find out how to become a member.

Conclusion

Back in September I posed a question as I concluded this column. I asked, "Could we be looking forward to any big announcements?" Like you, I could not have imagined such an amazing response as this opportunity that has materialized so quickly for the PCEA. Whether it's the laws of physics, karma or both, the PCEA is going through a metamorphosis before our very eyes. Let us not only watch as a new PCEA begins to emerge. Let's jump in and find ways to connect, engage, learn and grow with the membership, which will certainly benefit because of all of this.

It has been an honor to keep in touch with you by way of this column each month. But for now, I'll stop typin' and look forward to putting on my glasses to start readin' about all the great things to come by way of the PCEA, of which I am a proud and grateful member.

So long for now! □

DATA EXCHANGE Was Dead. Then a Deal Was Forged.

A decade in, IPC-2581 Consortium members say the pursuit toward widespread adoption of the vendor-neutral standard was well worth the rigorous effort. by **CHELSEY DRYSDALE**

Few engineers working in electronics manufacturing today predate the first efforts to develop and implement an industry-wide standard for intelligent electronics data transfer.

As early CAD tools were introduced in the late 1960s and early 1970s, IPC launched a vendor-neutral effort to describe electronics design data from schematic through test.

Meanwhile, Gerber Scientific had developed in the 1960s the common generic (read: unintelligent) format, colloquially known as Gerber, to describe information sent to its photoplotters. In the early 1980s, Gerber adopted and adapted the format for broader printed circuit board manufacturing.

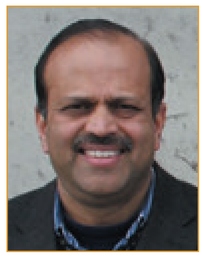
Not long afterward, other various standards bodies and private companies began work on their own formats. The names may ring bells among veteran readers: STEP, EDIF, GenCAD, and Valor's ODB (whose successor, ODB++, is still used today).

IPC-2581 was first released in 2004 and was originally patterned after GenCAM. It is used to transmit information between a PCB designer and a manufacturing or assembly facility.

But acceptance was spotty prior to 2009. That year, Mentor acquired Valor, a watershed moment that spurred EDA companies to support IPC-2581 as an alternative to Valor's ODB++. Motivated by the goal to ensure key standards would be developed by industry consensus, a group of ECAD companies formed the IPC-2581 Consortium in 2011. Within a year, Fujitsu had built a "proof of concept" board using only data sent in the IPC-2581 format, and the group was off and running.

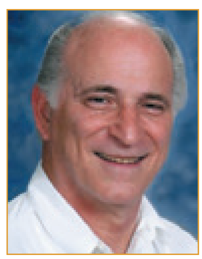
FIGURE 1. Consortia members were recognized by IPC in 2014.

The early consortium members shared their recollections of those early days with PCD&F in September.



Hemant Shah

Hemant Shah *(IPC-2581 Consortium Chair, then program manager at Cadence)*: Prior to 2010, most customers used Gerber for data transfer to manufacturing. This met the requirements for most PCBs, as high-density, more complex (e.g., flex, embedded) PCBs were not yet prevalent. Some large companies had started to use and depend on ODB++, a more intelligent data transfer format from a (then) small company named Valor. Valor worked closely with all PCB EDA vendors and manufacturing companies, and, like Gerber, ODB++ was considered EDA vendor-neutral.



Gary Ferrari

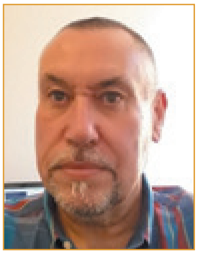
Gary Ferrari *(then IPC Designers Council executive director)*: In the early years, we were dealing with companies whose workers were primarily chemical experts. They were not as savvy with computers and felt very comfortable with simple software such as Gerber Scientific provided. The Gerber software was very basic and simple to operate. It told its hardware to open a round aperture, and it shined a white light through the hole and thus created a round image on photosensitive Mylar. If you wanted to make a straight line, one opened the aperture and dragged the light

beam across the photosensitive Mylar to create the line.

That's it, very simple. As long as the design was simple, this worked.

Joe Clark *(cofounder, DownStream Technologies)*: The primary factor was complacency – or maybe a better term is "risk aversion." Unintelligent Gerbers … worked, so no one saw the need to change, and the same format was often the exchange between the OEM and the CM, with the addition of a parts list.

Keith Felton *(then group director, product marketing, Cadence; now product marketing manager, Siemens Digital Industries Software)*: The need wasn't that strong for a new standard because a de facto one already existed.



Keith Felton

Hemant Shah: Adopting a new data transfer format never stuck because it required an ecosystem of software suppliers, design houses, PCB fabricators, assemblers, and testers. This ecosystem of supporters didn't exist, and no one tried to get them all together in an organized fashion.

Gary Carter *(then CAD manager, Fujitsu; now independent consultant, ThingWeaver Solutions)*: There was a recession and little industry support for IPC-2581. Not many of its original authors and creators were in attendance when I first joined the IPC committee and actively participated.

Too Proprietary

Rick Almeida *(cofounder, DownStream Technologies)*: Note Gerber is not actually a standard; it is a proprietary format owned by Ucamco. Likewise, the first true "intelligent" data transfer format – ODB++ from Valor – is also a proprietary format. The major difference between Gerber and ODB++ was licensing. [In other words,] a company had to be licensed by Valor to utilize the ODB format. This means there was always the possibility – regardless of how remote – that one's license could be revoked or not renewed. And what will become of the format if Valor ceases to exist as a company, or at least as an independent company? The marketplace – the ultimate decider – has a long memory of past formats that came and went – HPGL, EDIF, etc. – and was understandably skeptical of ODB++.

Jamie Wise *(vice president, Wise Software)*: Besides being a single file, open format, one of the needed features of this new standard was the additional safeguards for IP.

Terry Hoffman *(technical leader, Cisco Systems)*: My guess is other standards were not really a standard, or they were proprietary, which would make them difficult to adopt or gain traction.

IPC-2581 Comes … and Goes

(Ed.: IPC-2581 was developed in 2004, but it took more than six years for the IPC-2581 Consortium to form and back its implementation.)

Gary Carter: The initial standard was developed over many years and released in 2004. However, the internet bubble had burst; industry was in decline, and few paid attention to its publication. Most of the original authors and volunteers were engaged after publication. Budgets were tight.

Joe Clark: It's worth stating again Gerbers worked! And there were no external factors driving the need for change: technical or economical.

Technical factors as well affected adoption of intelligent formats by the mainstream market. For example, many companies are loath to send the entire design database to their offshore PCB foundries for fear of intellectual property theft, and because ODB++ did not support an XML version, there was not an easy way for users to send out subsets of the full design database.

An 'Overnight' Success

Joe Clark: The consortium … developed very suddenly, and the reason for this was due to a single significant event: the acquisition by Mentor of Valor announced in November 2009.

Hemant Shah: Mentor Graphics saw ODB++ as their IP and reinforced that on all companies that were consuming/producing it. Larger design houses that were using ODB++ but not using Mentor's EDA tools were perturbed and requested their own EDA vendors come up with an alternative solution.

Keith Felton: [There was] concern that ODB++ would stop being open and a de facto standard.

Rick Almeida: This was a game changer, and those EDA companies – the majority at the time – that were dragging their feet on support for this new format now had a strong reason to support [it]. A major competitor now owned the company that owned the proprietary ODB++ format that most were supporting via a license agreement. What now? How will the technical issues be addressed? What input will be allowed externally from Mentor for new versions of ODB?

In our view, self-preservation played a key role in the sudden creation of the IPC-2581 Consortium and its missionary zeal to make IPC-2581 the format of choice for all. The early members of the consortium were EDA companies, along with a few OEMs, most notably Fujitsu, but companies across the PCB design and manufacturing spectrum quickly came on board.

Gary Carter: At a Cadence Design Systems Technical Advisory Committee meeting, a top 10 list voted on by industry identified IPC-2581 adoption as a priority. We subsequently solicited membership across the entire value chain to join our newly conceived consortium specifically aimed to promote and support this standard. Prior to its formation, there was no proactive industry consortia focused on open-source collaboration for this particular IPC standard.

The Consortium Forms

Hemant Shah: The IPC-2581 Consortium was created in the summer of 2011 based on an industry need to have a nonproprietary standard to hand off PCB build intent to manufacturing.

We started with 12 founding members. (Today over 100 companies support the IPC-2581 Consortium.) The founding member companies believed in having an open, neutral standard not controlled by any one company. Everyone was collaborative. The challenge that the consortium faced was there were no software vendors that produced IPC-2581. Therefore, there were no software vendors that consumed IPC-2581. It was a chicken and egg situation: What comes first?

Gary Carter: The initial consortium meetings were filled with excitement and support for further development and implementation of IPC-2581. It was surprising to discover several companies already had implemented and utilized parts of IPC-2581 through the earliest tools that were available to import/export in IPC-2581's earliest published format. Little of this had been revealed publicly for a variety of reasons. Ideas for further expansion to fabrication and test soon emerged.

Terry Hoffman: The first few meetings after I got involved in the consortium were a learning experience for me. I had never worked outside my company to develop a standard, and I was getting familiar with the people involved and the standard, and learning the IPC standards processes.

Gary Carter: Clearly there was a vast difference of opinion on industry's willingness to openly collaborate. It took time to plant those seeds. Selling this to Fujitsu was also a challenge. We needed better tools to automate our design realization flow. We managed to win executive support to forge ahead.

Hemant Shah: The collaborative nature of the members, many of whom competed in the open market with each other, fueled the innovation to break the chicken-and-egg situation to create the first and only open, neutral industry standard for stack-up exchange. The passion and vision of the late Dieter Bergman for IPC-2581 was inspiring for many members who had the honor and privilege to work with him.

Selling the Public

[Ed: The consortium made its first public appeal to design engineers at an open session at PCB West in 2012.]

Jamie Wise: Once we finished verifying the process between CAD and CAM, we were ready to move to the next step in building a board using IPC-2581 data. Chris Shaw of Fujitsu provided the design, using Cadence Allegro to export the design in IPC-2581 format. Wise using VisualCAM prepared the files for manufacturing (design comparisons, panelize, pad removal, tear dropping, DfM analysis). John Dingley of JD Photo Data did the photoplots and worked closely with Phil Wain from CCEE to manufacture the boards. CCEE also ran electrical tests for opens and shorts, and AOI on the innerlayers to prove the boards were fully functional. Once Phil notified us the boards shipped, there was a lot of excitement. Chris (Shaw), Gary (Carter) and Ed (Acheson) couldn't wait to get their hands on the actual board.

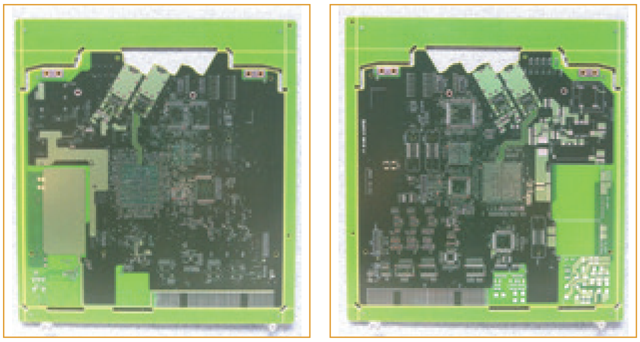


FIGURE 2. The Fujitsu test board.

Hemant Shah: It was a milestone for the consortium to talk to everyone about the adoption of IPC-2581. Almost everyone we talked to agreed there should be an open, neutral format for PCB design handoff to manufacturing. There was never an argument about using IPC-2581. The first challenge was awareness; the second challenge was to get the software vendors on both sides – the design side and the manufacturing side – to support it.

Terry Hoffman: I remember the PCB West forum that I just happened to drop into and argued against IPC-2581 in the beginning and then was for it at the end.

Gary Carter: It was a packed session with a very interesting panel debating the pros and cons of the IPC-2581 approach. The spirited dialog spurred a great deal of discussion and follow-up engagement with industry players. This brought a new group of supporters to the consortium and firmly established our path forward.

Rick Almeida: There was clearly a lot of interest. Like all new things, acceptance and adoption often start with small steps, and this was one of the first steps.

Off and Running

Gary Carter: Design tool companies were the key to getting out of the starting gate. Cadence, Wise and DownStream were instrumental in making that happen. Once we had the design tools available, IPC-2581A and B were utilized to prove a large part of the standard's capability to create value across CAD and CAM. This led to the fabrication of the first set of boards.

Even those who opposed this open standard – i.e., those in industry who had proprietary products that competed in this space – were beginning to see their customers would benefit from its openness, and some customers were pushing them to embrace it. Design, design verification, and manufacturing assembly were the first to embrace it. Fabrication and test soon followed.

Hemant Shah: Also, winning the DMDII [Digital Manufacturing and Design Innovation Institute] contract to get government funding for supporting IPC-2581 adoption.

Terry Hoffman: The event that stands out the most with IPC-2581 was the release of revision B. That release was the one that would enable my company to actually use the standard. That is when I started the long process of validating the IPC-2581 data in my very conservative company.

Joe Clark: Many milestones in the development of the IPC-2581 format were important and merit listing. However, for us a personal milestone stands out, and that is when we were able to demonstrate to Dieter Bergman – the true champion of the IPC-2581 format – the ability of several EDA tools to exchange the format.

The Fujitsu Proof of Concept

Gary Carter: This was the culmination of our effort to release Rev. B. It drew the attention of many producers and consumers of product data in the PCB industry that were already involved in development and adoption of IPC standards, as well as those involved in the development and marketing of proprietary CAD/CAM/PDM/PLM solutions. A few others read about it in blogs and social media venues. The battle in the fabrication and test space continued to hamper progress, but there were inroads forged there as well. PLM companies began to grasp the value of a digital product structure. We implemented this at Fujitsu and demonstrated how the standard supported it.

Hemant Shah: The companies involved were elated. Manufacturing companies were surprised that IPC-2581 indeed had everything they needed to build the board without any notes or back and forth with the design house customer. Three manufacturers built a real 12-layer product board from Fujitsu Network Communications.

Rick Almeida: This event was a significant step in removing the veil of doubt that many users still harbored. It was not the end of the work that needed to be done to ensure the adoption of the standard, but the beginning of the awakening of the market to its possibilities.

Jamie Wise: One of the most important milestones was when companies like Fujitsu started using IPC-2581 data exclusively for the whole design to manufacturing process and when Axiom set up its assembly “paperless factory” using IPC-2581 data.

Keith Felton: It showed the supply chain was capable of consuming IPC-2581.

Making a Difference

Terry Hoffman: The IPC-2581 Consortium has made a significant difference over the years. It is interesting how some of the features discussed in the consortium meetings have actually been implemented in other data formats after those discussions. So, the good ideas we came up with over the years have not only benefited IPC-2581, but also other data formats as well. Even so, we have seen IPC-2581 being adopted by many companies because of our diligence, our drive, and listening to people's ideas and requests.

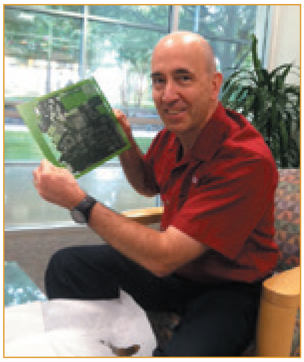


FIGURE 3. Chris Shaw of Fujistu opening the box with the first working IPC-2581 PCB.

FIGURE 4. Gary Carter, at right, sits next to Dieter Bergman at an industry meeting.

Gary Carter: More companies have plans in development or are in testing phases of internal implementation. It's slow, but it's happening.

Joe Clark: One can argue we dumbed ourselves down in our knowledge of the manufacturing process starting in the 1980s when we farmed out manufacturing to third parties. Some recent papers identify the adoption of an intelligent design exchange format as one of the keys to improving the new product introduction process, but given the results for GenCAM, which lacked any real support from the EDA market, the IPC-2581 Consortium has without a doubt generated awareness of and helped ensure the success of the IPC-2581 format.

Keith Felton: Adoption today isn't that high because the pressure to use a digital twin process still isn't that high. People continue to send Gerbers, and fabricators still waste their time cleaning them up due to competitive pressure. Given that most fabrication happens overseas, companies are wary of creating a single/complete product model to minimize IP theft. Companies that have bothered to optimize their process have achieved significant benefits.

Gary Carter: In many large companies there exists an aging workforce who are using a plethora of proprietary tools, processes, standards, and procedures. They also have established or entrenched "ownership" over the legacy methodology that had been in place for decades. Even if/when they do recognize the value proposition of the digital standards IPC has in hand, they often do not have the money, time or interest to invest in it. Or the people involved don't have leaders who are willing to assume responsibility. Simply stated, "It's not my job!" So, they continue doing what they have always done to toss today's document-centric work over the wall and out the door.

10 Years After

We asked our panel, "If you were told 10 years ago that you would still be at this now, would you have committed to it?" Their responses were overwhelmingly supportive.

Gary Carter: Absolutely yes. This effort was a tremendous challenge, and the cooperative work led me to interact with so many different people and professions throughout our industry. Fujitsu and IPC opened the door and made it possible. Many others in industry joined the initiative. The collaboration was amazing to see and rewarding to do in so many ways. I consider my effort promoting this standard to be one of my greatest professional challenges and achievements. I would not want to have missed the journey. My only wish is for Dieter Bergman to have been here with us to enjoy the fruits of his labor. I miss that man!

Terry Hoffman: It is probably good I did not know in the beginning how long I would be involved. However, I am the type of person who likes to follow through until a task is completed. I obviously believe the standard is beneficial and should be adopted, or I would not have been involved for a decade. The people in the consortium I have grown to know and befriend over the years have made it easy for me to continue to work with the consortium and IPC.

Keith Felton: No standards initiative is ever done. It's a constant evolution as technology advances driving change, and I think the effort was worthwhile.

Hemant Shah: We all want instant gratification, so a 10-year horizon would have been unimaginable at the start. However, the journey of collaboration and innovation is what keeps us all going. The IPC-2581 Consortium is unique and is proud of several innovations. Some of them worth mentioning: The first data exchange format built from the ground up to support all PCB production sub elements – BoM, fabrication, assembly, test, stencil – in the same file, so eliminating sync issues between those elements; the XML-based format allows for interfacing with, or augmentation from, external systems, such as PLM, ERP, and MES systems; bidirectional stack-up exchange between design house and manufacturing house eliminating late-stage surprises for getting the product out the door; bidirectional DFM exchange between design house and manufacturing house accelerating NPI.

Rick Almeida: Yes! Nothing worth doing is easy, nor garners instantaneous success. And there are setbacks. We are piggybacking on the vision and efforts of Dieter Bergman in this regard, and his example of continued diligence is serving us well. *(CD)*

Gary Ferrari: I teach designer courses and … I'd say that 70% are still using Gerber.

Jamie Wise: There was virtually no support for IPC-2581 10 years ago. Today we have all major CAD, CAM, and manufacturing and assembly companies using IPC-2581 in their daily processes.

Hemant Shah: IPC-2581 has a huge following. Several companies have standardized on IPC-2581. They are not going back. Manufacturing companies have provided incentives to their customers to provide IPC-2581. The approach that has worked is manufacturers quote a specific price if customers provide IPC-2581, and if they don't, and provide Gerber-based packages, the price goes up.

Gary Carter: It takes top-down executive sponsorship to create and lead the complex, interdisciplinary cross-functional team required to successfully lead digital transformation. There are lots of moving parts. Training is required. Risk-adverse human nature also plays a major factor here. Overcoming these barriers takes a masterful plan and buy-in from all parties.

Industry as a whole must change. It takes visionaries to transform this epic tale of weaving a stream of digital threads into the complete digital tapestry. That is where the goalpost stands and where the greatest opportunity to introduce disruptive technology lives at this moment. I believe younger engineers across our industry will be the ones who bring in the drive and the talent to get us across the finish line.

What any industry needs are new ideas, and one of the benefits of a standard intelligent design exchange format is it opens the door for small independent companies to innovate and create new tools, and competition is a good thing on many levels! In the past when formats were proprietary, it was nearly impossible to plug into an existing process, and this stifled innovation, a death knell for any industry. So, in addition to all the other benefits of IPC-2581 discussed, it also enables opportunities for new ideas and new tools to be created that can plug into an existing process flow. ▫

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UNDERSTENCIL WIPE Cleaning Yield Improvements

A study of the behavior of flux-stencil interactions.

by **MIKE BIXENMAN, DBA**

Understencil wiping has gained increased interest over the past several years. Changes in circuit design due to miniaturized components and highly dense interconnects have increased the importance of stencil cleanliness, both inside the aperture wall and on the seating surface of the stencil. A technology that wets the understencil wipe with a solvent-based cleaning agent is being studied to improve print performance and better understand the behavior of flux-stencil interactions. The cleaning agent dissolves the flux component of the solder paste to improve solder ball release from the stencil's bottom side and aperture walls.

Kyzen and Indium performed a study to characterize the relationship between wipe processes and bottom-side stencil flux/paste flow. A highly dense circuit board and a stencil with nanocoating was used to study the effects of the understencil wiping process. After each print, the stencil was removed from the stencil printer. The apertures were examined to inspect buildup in both the apertures and bottom side of the stencil. **FIGURE 1** shows the flux vehicle and some trace solder balls following the first print.

As expected, solder flux combined with solder balls increases with additional prints. Additionally, small apertures clog quickly. For wider pitch features, dry wiping the bottom side of the stencil is an accepted practice. On larger feature prints, a small level of solder paste on aperture walls does not materially affect the printing process. As feature size reduces, however, chemical assistance often is needed to dissolve the flux vehicle within the solder paste. Solder balls are released and collected within the wiping fabric. To better understand stencil wiping, the following wipe sequences were studied:

1. Dry/vac
2. Dry/vac/dry
3. IPA wipe/dry
4. IPA wipe/dry/vacuum
5. Engineered solvent wipe/dry/vacuum
6. Engineered solvent-aqueous wipe/dry/vacuum.

In the dry wipe studies, there appeared to be streaking on the bottom side of the stencil. Upon closer examination, the flux vehicle tended to become wiped over the bottom side of the stencil. Increasing the numbers of prints increased the level of flux spread on the bottom side of the stencil **(FIGURE 2)**.

IPA (isopropyl alcohol) is a common solvent wipe used when a wet wipe is used. However, paste manufacturers are moving away from IPA-based fluxes because they are a flammable solvent with a flash point and are becoming inefficient

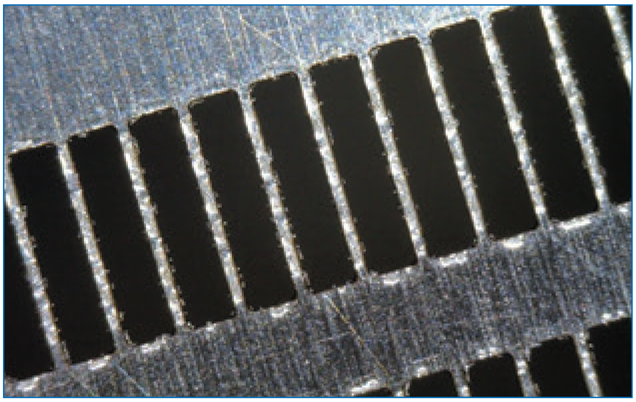

FIGURE 1. Flux buildup on highly dense apertures after one print.

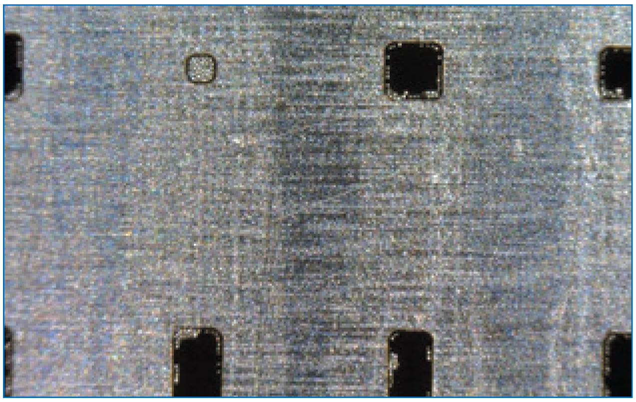

FIGURE 2. Flux streaks following dry wipe.

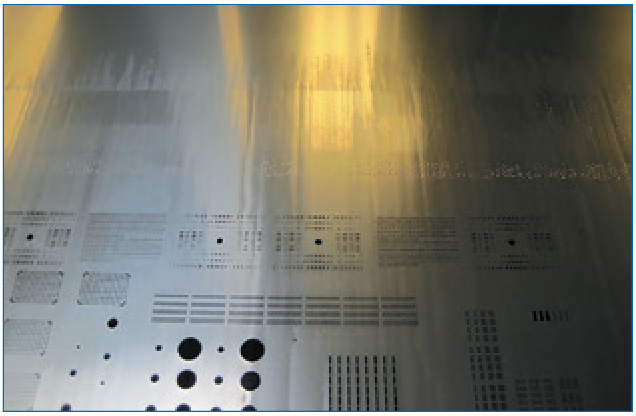

FIGURE 3. Solvent-water azeotrope wetness on stencil bottom.

for modern pastes. Current fluxes, especially no-clean formulations, require more specialized solvents. The solder paste used for this research was a lead-free, no-clean formulation. Following the IPA/dry wipe, the bottom side of the stencil was dry and mostly clean. Similar to the dry wipe, flux streaks were observed over the bottom side of the stencil. Flux streaks were also observed on the bottom side of the stencil in the third sequence of IPA/dry/vacuum.

A solvent-based stencil cleaning agent known to be effective at cleaning no-clean, rosin-based, wet solder pastes was evaluated. The engineered cleaning agent solvates the flux resin components within the wet solder pastes. The engineered solvent composition cleans and removes solder paste that tends to stick to the aperture walls and stencil bottom. The bottom side of the stencil appeared to be free of the flux stains. Unlike IPA, the engineered solvent is formulated within the combustible range. Due to its lower vapor pressure, the solvent dries somewhat slower than IPA. The bottom side of the stencil was dry following the dry + vac wipe process. The final solvent tested was a solvent-water azeotrope-engineered composition. The benefits of engineering a solvent-water azeotrope is the uniform evaporate rate, nonflammability, and low-VOC content. Potential risks of using this wipe solvent include ineffectiveness at removing no-clean flux resins, drying following the wipe sequence, and potential solder paste contamination. The solvent-water wipe/dry/vacuum process did not appear to clean the no-clean flux vehicle as well as the engineered solvent wipe. Of greater concern was a light film of the solvent-water azeotrope on the bottom side of the stencil after the wipe sequence **(FIGURE 3)**. Additional dry and vac cycles should be evaluated when using a slower-to-dry wipe solvent.

Conclusion

The research performed here found that understencil wipe solvents match with the flux compositions used in lead-free solder pastes and remove fluxes more effectively than IPA. Engineered understencil wipe solvents removed flux stains and left a dry surface following the wipe sequence. The solvent-aqueous understencil wipe solvents appeared to clean well but were slower to dry, and may require additional dry wipe and vacuum steps. ▫

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ROI, continued from pg. 16

is important to you and your business. Tune out the pundits and talking heads and focus on communicating with your suppliers and customers. Is customer demand for product stable, or increasing or decreasing? How confident are customers in their projections and forecasts? Being on top of this critical information is more important now when the supply chain is in flux than during normal times.

Being in sync with suppliers is equally critical. As unpleasant as the news may be regarding specific product availability and the price that must be paid for that product, it is better to be in the communication loop than be forgotten by silence. More than ever, work your supply chain actively and intelligently. A fatigued supply chain requires diligence and proactive communication to minimize business disruption. ▫

BGA REMOVAL Using Focused IR

By concentrating heat onto the part, the BGA avoids excessive temperature. by **VARDAAN MONGA**

Recently, a customer asked if we could remove a valuable BGA from an existing circuit card assembly. About 1,000 of these BGAs could be removed. Our customer is a reclamation company, and they planned to resell the BGAs, which could fetch upwards of $400 each because of the current chip shortage.

The BGA itself is an older version of the Intel Altera family of products (**FIGURE 1**). While deemed obsolete by the manufacturer, the part is certainly usable, and due to the chip shortage, our customer might understandably obtain a good price for these older parts, which can be used as replacements for newer models.

Using a BGA rework station, a focused infrared (IR) model, we first created a thermal profile (**FIGURE 2**) for removing the BGA that would heat it to below its maximum rated temperature; the upper limit for the part is typically 250° to 270°C. The rework cycle brings the part up to 220° to 225°C, melting the solder connecting the BGA to the circuit board, and permitting the BGA to be lifted off easily without pulling or damaging the solderable pads on the board. Once all the BGAs are removed, they are reballed and packaged for resale.

The thermal profile we developed for our IR rework machine is similar to the profile used to attach BGAs in an IR production oven. We ensure the part does not go above the maximum allowable temperature (250° to 270°C). The IR rework machine concentrates heat onto the part itself and, in our opinion, is more effective for BGA rework than a hot air-based system. We were also concerned the hot air might cause the BGA to exceed its maximum allowable temperature and thus damage it.

The average rework cycle time is three to five minutes per part, considering the size of the BGA and the thickness of the board. Crystal heaters on the bottom of the rework unit preheat the board from below to minimize thermal shock and make it easy to remove/reflow the part using the IR radiation from the top. A regular water-soluble, washable flux is used to facilitate clean removal.

The BGA itself has a shiny metal housing, and we were concerned at first that its reflectivity might be an issue in terms of temperature control and repeatability, but it wasn't. The reflow unit simply adjusts the energy based on the temperature reading the thermocouple "sees." In rare cases we can accommodate the issue by applying a special nonreflective tape to the part.

After a BGA is removed, the surfaces are cleaned by wicking away any residual solder. Once cleaned, the BGA is ready to be reballed, packed and shipped to the customer. ❑

VARDAAN MONGA is an electrical engineer at BSU Inc. (bsuinc.com); vardaan@bsuinc.com.

FIGURE 1. Reclaimed BGAs like this Intel Altera are selling for up to $400.

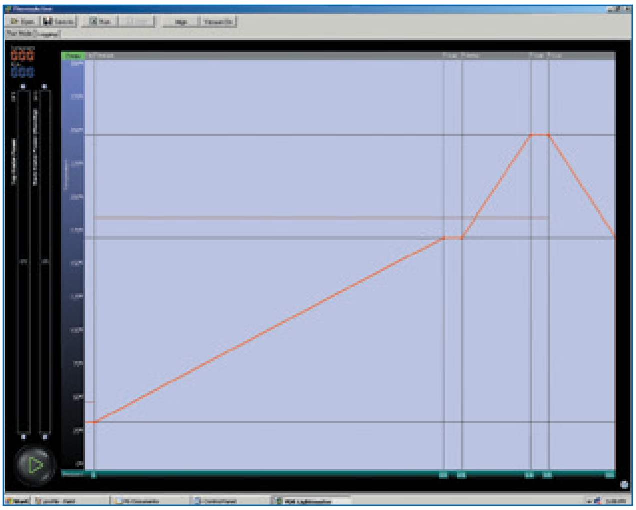

FIGURE 2. A reflow profile similar to the one used to remove the BGA.

Volthub: Connecting the SUPPLY CHAIN

A new platform for streamlining procurement takes shape.

by MIKE BUETOW

Supply chain has been the story of the past year, and a new face to the industry proposes to help resolve that by connecting electronics engineers with printed circuit board assemblers.

Vincent Bedát is a mechanical engineer and recent MBA graduate of the MIT Sloan School of Management. He is also founder of a San Francisco-based startup called Volthub. I came across Volthub as part of an announcement of the finalists for the MIT $100K Entrepreneurship Competition. That program has various aspects to it, but in short it's a way to match early-stage teams with industry experts and entrepreneurs, and perhaps gain some seed money along the way. Some of the companies that have been part of the competition over the years include HubSpot and Akamai Technologies.

Bedát hails from Zurich, Switzerland, where he also studied, graduating with a master's in mechanical engineering from ETH Zurich. He then went on to work at the robotics startup Synapticon in Stuttgart, Germany, as a mechanical engineer and eventually project manager.

In 2019, Bedát came to Boston, where he started on an MBA at MIT's Sloan School of Management. There, while taking classes, he also developed a concept for a platform to accelerate the rate of innovation in hardware development by streamlining the procurement process. Upon graduating from MIT in June, he has relocated to San Francisco to further develop the company.

Q: Volthub is creating an interface for assemblers and customers, and I want to get into that in a moment. But first, when did you recognize gaps or inefficiencies in the printed circuit board development process?

Vincent Bedát: I think that started very early on, as I started in mechanical engineering to create custom parts. Working with contact manufacturing, I noticed, going from some fancy CAD software back to emailing PDFs of technical drawings, etc., and then having to email back and forth with contract manufacturers to really go through all the requirements before manufacturing can happen, how this process felt very outdated. As a project manager at Synapticon, I noticed how much bigger the issue was with PCBs. You have a huge bill of materials for a board that has to be custom-made, and the assembly process, and a lot of different suppliers that have to come together to create a final product. To see that this interaction was still going on through Excel spreadsheets, PDFs, and screenshots with little red circles showing there's an issue somewhere was really daunting to me. That's why, when I started the MBA, I decided to look into the possibility to make this more efficient.

Q: So you came to graduate school with that already in mind.

Bedát: Absolutely. I remember the interview process, and I knew I wanted to go into entrepreneurship. I wanted to do something to help solve those problems I experienced in the past, and how exactly to do that was totally still to be determined. Volthub is constantly evolving, getting feedback from the industry and adjusting to it, but the problem was defined from the start in 2019.

Q: Do you have partners or other team members?

Bedát: Luckily, through the MIT program, I have had a lot of colleagues helping me out, whether from class, or advisers who have been helping. We now have two software developers, plus myself, and we aim to have one to two cofounders at the end of this year who have a lot of experience in the industry and a lot of experience with software development. It has been a great combination of a lot of very smart people from MIT, friends from back in the industry, and a lot of companies that I've started to talk to that absolutely would love to have a solution like Volthub that are collaborating with me as we get ready to launch.

Q: Just for clarity, the name of the company is Volthub, and that is also what you're calling the platform?

Bedát: Yes.

Q: Many folks have tried to build the proverbial better mousetrap for matching designers/buyers with manufacturers. Where do the existing systems break down, and what makes Volthub unique?


Vincent Bedát

Bedát: At the very core, what we are currently building is a platform for OEMs that have designed a PCB product to be able to define their project; to define the requirements they expect of the PCB panel; to define the bill of materials, which components to choose, which ones can be chosen by the supplier, which ones are delivered by the customer, which ones do the EMS have to give? All of those small requirements that combine and create a lot of emails and questions back and forth. We created an interface where customers can define all of that and then share the project with their EMS, and once the information is digital, all the companies down the supply chain can efficiently share the information all the way to the component distributors and back to the customers without having to go through emails with hundreds of people cc'd, hundreds of files attached, and very quickly losing track of "which document is the actual one?" The code is a platform to define a project and collaborate within the supply chain.

Q: Would the participants on that platform already know each other and have existing business relationships, or is that an area where you actually might find a new supplier?

Bedát: Right now, we are working with [a system in which] two people know each other who want a more efficient way to collaborate. We have also received feedback from both sides that the desire is there, once a project has been fully defined, if they don't have a partner yet for that specific project, to find somebody who has the capability to deliver, and the same point of view from any EMS company or PCB manufacturing company: to find potential customers who don't know about them, and they could find new projects, new valid leads. So, we are building out Volthub to also help find partners.

Q: But it's more than just a platform for finding a new supplier. It could work in a vacuum where you already had an existing manufacturer and their customer, and they could use this to communicate both with each other and then up and down the rest of the chain.

Bedát: Exactly. Keeping track of the information that has been shared over the years of different revisions, different quotes, different requirements that have been set. This is the core of the platform; it's a shared project. Based on that, we're going to establish more elaborate features.

Q: Traceability, of course, is a big deal in data management and a huge thing in this industry. Another is IP security. How do you protect that as this information is getting transferred and shared?

Bedát: It is one of the most essential problems we have to be very careful about. Aside from using the most advanced security tool for any file that's saved on Volthub or any data that we gather for our customers, we still think the established connection that happens on Volthub will not be between two strangers. There will be a contract between the two that can be done over email first, and we are looking into the way this can be done over Volthub very easily, like an IP or an NDA contract that can be signed by both parties before the project is even shared. But at the core, we are starting with those connections between two companies that already have dealt with each other and already have those contracts in place.

Q: Is it too early to start talking about beta testing and when that might happen?

Bedát: We were very close to launch at the beginning of August. We have a few additional features from those initial beta customers, and now are working on those, but we are indeed looking for more beta customers, OEMs that want to order PCBs or EMSs that want a digital platform to receive inquiries. Any beta testers that want to join may email info@volthub.io, and I will gladly initiate the chat.

Q: A couple of EMS companies today have really focused on having an all-digital platform, a much faster, not just time-to-market, but time-to-quote, time-to-delivery, time-to-exchange-of-information solution. Instead of building such a system in-house, however, an EMS could simply engage with Volthub and get there without having to spend maybe thousands of hours of internal time developing their own platform.

Bedát: That is exactly where we are heading. We want an EMS to be able to do that without needing to hire software developers and leading a software team. That is not within a core business of an EMS. We had those discussions when those OEMs we were talking to said, "We love the interface, but we want that same interface with our preferred EMS." Now we're talking to those EMSs. That is really the challenge they have: Should they start hiring software developers and create a software department, or is there another solution? That is the gap that Volthub has filled. ❑

Ed.: This is a transcript of an interview first recorded for the PCB Chat (pcbchat.com) podcast.

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Will ECAs Finally STICK?

A new study reveals emerging applications for attaching very-fine-pitch parts using low-temp methods.

by MIKE BUETOW

Electrically conductive adhesives (ECAs) have been touted for decades as a potential replacement for solder. Technology roadmaps by organizations ranging from IPC to the Surface Mount Council often listed ECAs as a "coming" technology, and scores of papers have been presented highlighting possible uses and likely end-products.

In early October, the international research firm IDTechEx released a new study called "Electrically Conductive Adhesives 2022-2032: Technologies, Markets, and Forecasts." Matthew Dyson, Ph.D., a senior technology analyst at IDTechEx specializing in printed, organic and flexible electronics, spoke with Mike Buetow about the study's findings.

MB: Tin-lead and lead-free solder alloys are a blessing and a curse. They generally wet well and offer robust mechanical strength and conductivity. They often are the least expensive method of component attachment, and we seem to know all the quirks of reflowing them. But, they aren't environmentally friendly in today's context. Lead-free alloys often require reflow temperatures that risk damage to sensitive components, and they aren't readily applicable for some substrate materials, like PET. Per your research, ECAs have an opening to gain market share in certain applications. What can you tell us about that?

MD: ECAs are not a completely new technology. They're already widely used in the display industry and quite a few other places. I think where they really shine is you can use them at significantly lower temperatures, and you don't need to go through this whole reflow process as with solder. You can imagine an ECA as a kind of conductive glue. There are two types. It allows you to directly place that component and then apply a relatively small amount of heat to cure it, and that component, be it an LED resistor or a capacitor or so on, is immediately secured on the board, rather than having to go through this whole reflow process. Of course, the ECAs are more expensive than solder, which is a downside, and they don't come with the kind of self-alignment benefits you get with solder. That can make using them a little more time-consuming or expensive because the components won't get dragged into place the same way they would with solder. But they do have a lot of applications, particularly as we move toward a flexible, embedded electronic kind of approach, where the conventional reflow method and materials such as FR-4 substrates don't really apply anymore.

MB: You mention two types of conductive adhesives. I assume you mean isotropic and anisotropic.

MD: Yes. Isotropic adhesives (ICAs) are really like conductive glue. Ultimately you've got a sort of loading of silver particles and some kind of conductive species with some kind of epoxy with sufficiently high loading that there is a conductive pathway between all those embedded particles, and you can just use them to stick your components on. Of course, the challenge with that is, if you want to attach to very small contact areas to achieve fine pitches, you're going to dispense these isotropic conductive adhesives incredibly precisely. That can be quite difficult and/or expensive, so that's where anisotropic adhesives (ACAs) come in. They only enable electrical or thermal conductivity in one direc-

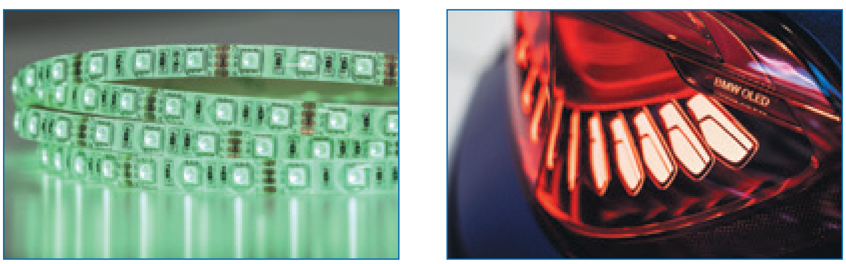

FIGURE 1. OLEDs are a common application for conductive adhesives.

tion. The main technology would be where you have a much lower loading of conductive particles, and then by squeezing your components onto the top, you trap this conductive particle between the conductive trace that you're trying to attach it to and the conductive part of the component. It's only in that vertical plane that conductivity occurs. That makes this sort of resolution requirement for placing components significantly less challenging because some of that pitch capability is coming from the material itself.

MB: Could you talk about what some of the new technical innovations are in the ECA space?

MD: I think the most interesting one is the development of what I call field-aligned conductive adhesives. The basic idea is, rather than achieving anisotropy by trapping a conductive particle by applying heat and pressure, you can instead align the conductive particles within the anisotropic adhesive in advance by applying either an electric or magnetic field. There are a few different approaches here, but the basic idea is by applying a field, the particles will line up along those field lines in a similar way to iron filings on a piece of paper, and as a result, the anisotropy is already there when you come to mount your component. That means you can achieve finer pitches and don't need to apply so much heat and pressure when mounting the component, which of course makes it faster and means you can use more thermally or physically fragile components.

MB: Your study looked at the different applications that have potential for ECAs, but did it also look at which types of components might be more likely to be used with ECAs?

MD: Yes, absolutely. You can certainly use them across a whole range of components, including BGAs, microprocessors and so on. The ACAs come into their own when you get to the smaller fine-pitch components. As this kind of resolution gets smaller, it becomes increasingly desirable to avoid those constraints around how exactly [the component] is positioned and whether these small amounts of adhesive can be deposited, versus can I just put on my components and the conductivity will be entirely vertical? There are some approaches now, particularly with anisotropic conductive films, which can get down to the tens of microns, which are certainly quite challenging to achieve with ICAs, for example.

MB: In the mid-1990s I worked on the IPC standard for electrically conductive adhesives, so obviously these have been around for a while. What, if anything, has changed that gives you reason to believe there is more potential for market penetration today?

MD: People are increasingly looking at electronics not as something that comes as a rigid component from [offshore], but as something that is incorporated in the device during the manufacturing process. That means this conventional mass production of PCBs is no longer applicable. If you move toward those kinds of embedded or flexible devices, you are going to need different techniques. That's not to say regular PCB production is going to disappear by any stretch. I imagine the motherboard on your laptop will be a conventional PCB for a very long time, and probably very cheap, relatively commoditized circuits. But there's a whole space in between those, such as making HMIs – human machine interfaces – center consoles in vehicles, in aircraft where weight is really important, even consumer devices, rather than designing your product around fitting a rigid PCB. Once you accept the idea you can put your electronics wherever you like, there's a lot more freedom of form factors.

And then there's all the applications for flexible electronics, particularly in the kind of wearable/healthcare/wellness-type space. This would be for things like continuous health monitoring, where you can attach a skin patch that would monitor, for example, your heart rate, temperature, or things like your ECG more precisely than a smartwatch and probably could monitor a wider array of things, and that would incorporate an antenna and some kind of digital processing to interpret that data and then send it to the cloud. You can imagine having multiple ones to enable an advanced kind of ECG of the type you might normally have to have in hospitals. There's a lot of interest in wearables. There's not that many of them, and those that do exist have a little plastic box with a PCB in it, which makes it significantly less comfortable to wear. Once those electronics can be mounted onto a flexible or potentially stretchable substrate, it becomes way more compelling because it's conformal, much lighter, much smaller, doesn't have a plastic box on top, and you can imagine them integrating electronics into your clothing with similar means. You have antennas in there for monitoring your health or sporting performance or whatever. You could have electronics also providing heating. Obviously, that would also need the control circuitry, but you don't necessarily want to have a whole PCB in your jacket. There are all these applications for very flexible and embedded electronics.

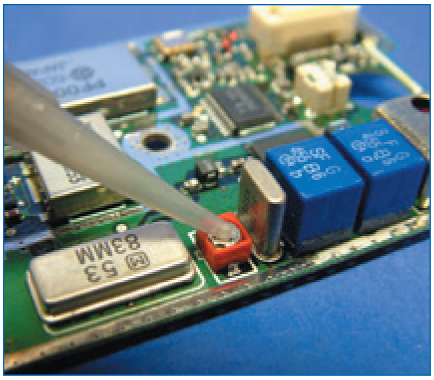

FIGURE 2. A two-component, nickel-filled electrically and thermally conductive epoxy.

MB: Your response reminds me of some reading I've done about electronic skin, or electronic patches.

MD: The way I see it is electronic skin is a kind of next step from a skin patch. At the moment, if you want some kind of electrical monitoring as a skin patch, you have some kind of sticky electrode, and then there might be a little bit of conductive ink using the wiring, and you'll have a PCB and little plastic box [the size of] a matchbox, or maybe a bit smaller, that sits on top. The next step is to mount those electronics directly onto the flexible or stretchable substrate. That would often be determined to be flexible hybrid electronics in that you're mounting some of these ICs, which have a little piece of silicon and may or may not be rigid. There are some examples of flexible but still inorganic ICs. That would be a kind of intermediate case. And what you're mentioning with electronic skin – I think I've also heard it referred to as epidermal electronics – there's some great work from Stanford, which uses some kind of OLED display put onto someone's hand. I think there's a little pressure sensor that's completely conformal to the skin. In terms of commercialization, those sorts of skin electronics are quite a long way off. The intermediate stage of these skin patches you can certainly see becoming much more widespread over the next five to 10 years or so, possibly sooner.

We looked at a wide array of applications these ECAs can be used in. We describe the technology in terms of these materials, and look at some of technical innovations, such as field-aligned adhesives, and at a whole range of applications where they could be used, like in-mold electronics and automated HMIs and the skin patches you mentioned.

MB: Is your forecast for ECAs generally optimistic over the next 10 years, and will that be at the expense of solder? You've described a lot of new and emerging applications that simply weren't around in the past for solder to take hold in.

MD: I think that's true. I think most of the gains will be coming from these emerging applications, and I'm certainly not [thinking ECA] will completely replace solder. What I do think is there are emerging applications where solder isn't particularly applicable, versus those new applications that will present a substantial opportunity for these different types of ECAs. I would say as well the solder industry is progressing, and there are innovations such as ultra-low temperature solder, either by choosing a different alloy or a rather nice example of an early-stage US firm that can encapsulate supercooled liquid solder and little nanospheres that explode during manufacturing, which enables solder to be used on these thermally fragile substrates such as PET, which will be needed for low-cost electronics.

Another application I think is beginning to emerge after quite a few years is smart packaging. You might be aware of RFID tags, as you get them on clothing labels, and those all utilize electrically conductive adhesives because they all have a tiny or very low-cost, very simple silicon chip that provides a bit of identification for that specific item. But as smart packaging becomes more common, it won't just be about identification; it will be about sensing parameters over time, things like temperature, movement, those kinds of things, and then ultimately feeding that information back to the cloud by an antenna. Say companies contract their products throughout the supply chain and potentially even in your house. Those devices will need to be produced in very, very high volumes. To achieve that, you need to run your equipment at very, very high speeds because you are only mounting a very simple single little chip, and hence using electrically conductive adhesive is the way to go because you don't need to do the whole reflow cycle. If you imagine all clothes have some kind of label on them or food packaging, pharmaceuticals … all have little computer chips in them, but they only need one, and it's a pretty simple circuit, and certainly one of those significant players there has just received a fairly big investment from SoftBank. These are the kinds of things we discuss in the report, these emerging applications. Certainly the potential for smart packaging is huge, but people have been saying that for a while. However, it does seem like there's another round of interest, another recent chunk of investment going into it. Similar technologies such as flexible ICs are also really promising and can potentially lower the cost. ❑

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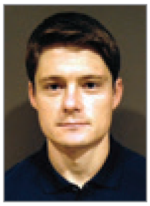
Food-Processing Methodologies Offer Ideas to Chew On

Leveraging centralized resources for efficiencies across three facilities in as many countries.

JIM BARNES is president at SigmaTron International (sigmatronintl.com); jim.barnes@sigmatronintl.com.



SOME INDUSTRIES HAVE specialized end-market requirements. For example, corporate headquarters in fast food and fast casual restaurants dictate menu items and the equipment needed to support those items by region. Franchisees have choices in equipment configuration and a timeframe in which they need to buy it from a designated food processing original equipment manufacturer (OEM). They typically order very small quantities, however, making it challenging for a food-processing OEM to fulfill orders utilizing a single manufacturing location and centralized stocking model. There are also regional differences in input power voltages, cycles and plug styles. Preferred language for control overlays also varies. This creates a configure-to-order (CTO) dynamic that adds complexity to the variable demand model. Outsourcing adds flexibility to this equation because it gives food-processing OEMs access to shared production resources which help mitigate the production resource utilization inefficiencies that this type of high-mix, variable-demand production can create. It also helps OEMs more easily support a global customer base with minimal investment in production resources.

Regardless of whether the project is outsourced, when these units are manufactured in a single location, the wastes of overproduction, waiting, transportation and inventory are likely to be significant. At the same time, dividing variable-demand, small-lot production among multiple facilities has the potential to create inventory imbalances and production inefficiencies, particularly if the work is divided among contract manufacturers and managed separately by region. Lean manufacturing philosophy provides guidance on finding a balance that supports customer requirements while still leveraging some economies-of-scale.

In SigmaTron's model, this type of project is built in the US, China and Mexico. There is a focus on standardizing project support and centralized resources to leverage economies-of-scale while utilizing local suppliers for regionally specific components.

For example, common components are sourced centrally via SigmaTron's purchasing organization and shipped to each facility. This minimizes transactions and leverages purchasing power. A combination of proprietary and internally developed systems is used for enterprise and shop floor management. All facilities utilize a common ERP system. Proprietary real-time supply-chain management tools enable the project team to track demand, material on order, inventory, work-in-process, finished goods and shipments at both an international purchasing office (IPO) centralized level and the individual facility level. This system also can provide real-time status information to the food-processing OEMs. If demand is increasing in a specific region, the supplier is contacted, and shipments are redirected to the area of high demand. Regionally specific components related to input power and language-specific control overlays are sourced in proximity to the build site, reducing shipping cost and logistics lead-time; i.e., the waste of transportation. This combination of real-time visibility into demand and use of local suppliers for regionally specific components minimizes the potential for inventory imbalances due to variations in demand, while optimizing the supply chain pipeline and reducing logistics costs.

Equipment is another area of potential inefficiency. While most production equipment resources are shared with other projects, minimizing the waste of non-utilized talent, the test requirement is unique. Once again, the company has leveraged centralized resources. Their test engineering team has developed a standard test set capable of testing all product configurations and shipped those test sets to all facilities. This optimizes development, support and maintenance activities, while leveraging the economies-of-scale represented by a standardized test platform strategy.

Products are shipped directly to franchisees as they order, minimizing finished goods inventory requirements, shipping cost and transit time.

This type of solution provides the food-processing OEM with the standardization benefits and purchasing power of working with a global manufacturer and the advantages of a localized CTO solution to support end-markets where their customers are ordering small quantities of CTO product and want short lead-times. Just as visible factory layout helps a production team identify bottlenecks in production, company-wide real-time systems help identify imbalances in demand-to-forecast early enough to shift material to the correct facility.

Lean manufacturing philosophy is extended through the entire product realization cycle for the food-processing OEM. Raw materials are transformed into product based on an order (pull signal) from franchisee customers and built in each customer's region, minimizing the wastes of overproduction, inventory, waiting and transportation. The cost-related benefits go far beyond the price paid for finished units, since the regional logistics efficiencies eliminate a number of costs that would otherwise be incurred. □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The Customer is Always … Right?

Reading minds is outside our capability.

RUNNING A BUSINESS is hard. There are many moving parts to contend with, both from the customer's side and that of the enterprise itself. A knife's edge of difference enables those parts to work symphonically rather than as a cacophony. The cacophony often prevails. Not for nothing is the practice of good management often characterized as more art than science, especially when "good" is a matter of perspective and bias.

We're dealing with humans. Most simply want to make a living and provide for those closest to them. For that reason, when studying economics in college long ago, I always found incongruous the assertions of those theorists who tried to reduce human behavior and all its attendant unorthodoxies and irrationality to a series of simultaneous equations. Despite the mathematical elegance, something didn't fit into such a neat solution. People aren't abstractions, but I was too young and inexperienced to adequately express my misgivings about the incongruity. Plus, I wanted an A.

Time has added depth, and depth comes from time-tested experience. Experience, and hitting many walls, reveals a range of motivations.

A full career offers countless somethings that don't fit. Customers are strange critters. Here is a sampling of three:

Scenario 1: How can we help you?

"We want to test our board."

Thanks for clearing up that confusion. How?

"You're the expert. Tell us."

It's your board. You're the designer. What do you want to test?

"We worked with your company for some testing needs and x-ray inspection in the past. Now we are working on a new product that will require functional testing, and I would like to invite you to one of our virtual meetings. We would like to hear more on the functional testing that can give us close to 100% confidence the board is fully functioning and any other services that your company may provide. We are reviewing the NDAs, and hopefully you or your representative can join us on one of our meetings and go from there."

Two months later, the NDA is signed, countersigned a month later. Discussions about schedules about meetings about ground rules about SOWs about testing immediately follow, one more month later.

What are you trying to find out about your board?

"That it works."

Go to the head of the class. Four months' waiting for one profound insight?

Define "works."

"The green light goes on, and the red one doesn't. The board is in design. Once we have preliminary design data, we'll send it to you."

Two months later:

In addition to the usual board files and documents (CAD, Gerber files, schematics, bill of materials, assembly and fab drawings, etc.), we need to know in writing what it is you want to test and how you want it tested. This usually takes the form of a detailed written statement of work (SOW) describing what you will supply; what we will supply; what tests and measurements you expect will be performed; and what outputs and data they will produce, and in what format. Expectations and deliverables – inputs as well as outputs from both parties should be made unambiguously clear by this document. The document should also note what, if any, diagnostic capabilities will be expected to be performed using the contemplated test setup. That should be the initial basis for discussion. Until you can produce that document, there is little for us to talk about.

Two months later:

We have received a preliminary netlist, bill of materials, and a set of mechanical drawings. We've also received a spreadsheet that appears to be either a compilation of testing ideas – a "wish list," if you will – or a snapshot of the minutes of an engineering brainstorming session, taken directly from a white board unedited. The notation resembles C++ rather than standard written English. Unfortunately, after six months we are no closer to discerning what you want. You are the customer, and you need to help us, so we can help you. There is no shortcut to this.

Nevertheless, they persist:

"Can you now quote this?"

No.

"Why not?"

You still haven't told us what you want. We are not mind readers.

"We'll get back to you. It'll probably take a few months."

The things one learns after college. Economic theory doesn't speak to the problem of building the plane while simultaneously attempting to fly it.

Eight months later, we're still waiting. A human child has a faster gestation period.

Scenario 2: "We have a board we are designing for a system intended to expose vulnerabilities in secure

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networks. We need a quote for flying probe testing and a thorough description of your capabilities. Oh, and can you explain how flying probe works?"

You mean stuff we're not supposed to talk about, by agencies that don't exist, that need capabilities that never happened, are not happening, and have no chance of ever happening, and that you don't understand anyway? Oh, and this meeting never took place, correct?

"Exactly."

Reading you loud and clear.

"We'll post files for you to download on our Crypt.share account. They are very large, like the board."

Large, like your ignorance. Crypt.share. Irony noted.

How big?

"24" by 28" (for you Russian spies, that's 609.6mm x 711.2mm)."

How many layers?

"36."

How many nets?

"Approximately 14,000."

How many installed components?

"Approximately 15,000."

Do you have files ready to review?

"Only partial design data."

Then I guess I can only give you a partial quote. I'll leave a page or two out of our usual boilerplate.

"Management wants a complete quote and a time estimate for turnaround."

When will you have a complete, and final, set of files ready for testing?

"In about 60 days."

How many boards are you building?

"Two."

Do you want us to evaluate the board for JTAG/boundary scan testing, in addition to the standard flying probe program?

"No, because that will only add delays. We're on a tight build schedule."

That's a contradiction in terms with a board of this size and complexity. When do you expect to have the two assembled boards ready for test?

"In about 90 days."

And you want a quote from us now, based on an incomplete design?

"Yes, and please base it on your fastest possible turnaround."

That's a relative statement. Programming and debugging a flying probe program will probably take two weeks.

"How many shifts do you operate? How many engineers can you dedicate to this task?"

Same as the number of micromanagers needed to screw a program designing LED bulbs.

"Pardon?"

Nothing.

"Management is hoping for a two-day turnaround."

Management can hope for many things, 90 days out. Hope is a good virtue to have. They'll need it (in abundance). It all looks so pretty color-coded on a white board.

"Why is that?"

Sorry, to answer that question I'll have to charge you for consulting time.

"Can we still get a quote?"

Yes, based on the data we have, and subject to change once we have the actual production data. Call it budgetary, as in B.I.G.

The quote is submitted. Memorable in dollars as well as time. Predictably, there is silence. Three weeks later, I have to reinitiate contact.

Well?

"We decided to go in another direction."

How many directions are there? What's the real reason?

"Our EMS partner was uncomfortable about rework in the event of a board failure."

Easy enough to solve. Just build a perfect board. Two of them, in fact. Should be a slam dunk.

"They were concerned about the logistics of handling repair and rework, and letting that process take place outside of their purview was unacceptable to them."

So, you let your EMS company call the shots? We never discussed this subject in our conference calls.

Somebody woke up at midnight in a cold sweat, fearing a loss of control.

"We won't be needing your services this time around. We'll keep you in mind for future projects."

How comforting. I'm sure you or your algorithm will do just that.

Cue voodoo doll pins. Nothing says "we'll keep you in mind" like an eternal curse.

continued on pg. 43

Poor Fabrication and Rework

Get agreement on what constitutes "rework" – and a capable operator.

THIS MONTH WE look at etching defects and their removal – or presence, as in the case of FIGURE 1. A customer was surprised to find a batch of bare boards with this level of rework.

First, it's important for customers and their suppliers to define what is considered rework. Excess copper is clearly present under the solder mask and should have been noticed during final inspection, but also long before, during AOI. At that stage, depending on the specification and level of rework required, it may have been better to scrap the panels. If it were a double-sided board, I would scrap the panels. If it were a multilayer board, I would ask the customer if I could rework the boards to reduce delays.

Many skilled operators could have performed this rework much better. Notice the lighter green color in the mask window. This would not be acceptable at any level of international bare board standards.

We have presented live process defect clinics at exhibitions all over the world. Many of our Defect of the Month videos are available online at youtube.com/user/mrbobwillis. Find out how you can share our new series of Defect of the Month videos to explain some of the dos and don'ts with your customers via CIRCUITS ASSEMBLY: https://bit.ly/3mfunlF. ❑

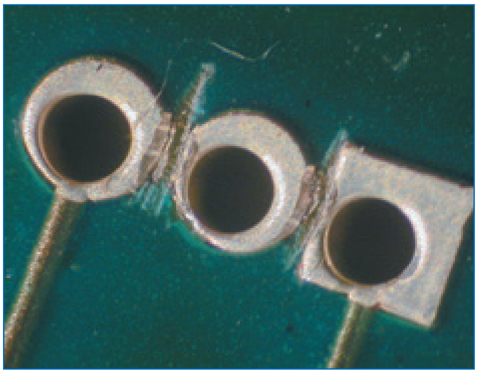
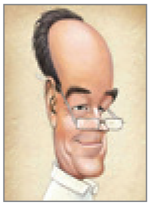


FIGURE 1. Example of poor etching.

BOB WILLIS is a process engineering consultant; bob@bobwillis.co.uk. His column appears monthly.



Seeing is Believing, continued from pg. 42

Scenario 3: "We have just sent you a 32-page statement of work."

I'm impressed.

But skeptical. Multisyllable words fill up pages. Shouldn't confuse form with substance.

"In accordance with our SOW, we'd like a quote for x-ray inspection, microscopy, dye and pry, and cross-sectioning of a sample set of boards, both before and after thermal cycling. As this is an automotive application, we'll need a full report of findings, with high-resolution images to support those findings. In the event of a documented failure, we also reserve the right to request supplemental SEM, EDS/EDX, XRF, FTIR, and C-SAM analysis, if further investigation to an elemental level is deemed necessary by management."

That pesky management again.

This is the third version of this SOW. The first was issued 18 months ago; the second, 12 months ago.

I can see the cutting-and-pasting. It reads like it was assigned to an intern, condemned for a summer to scribble away at requirements dictated from a textbook. Penance for the sin of being young and eager.

Why the changes?

"Other vendors' comments were incorporated in the updated SOWs."

Are we competing against them for this business?

"No. One vendor dropped out after we awarded them a contract. Another was disqualified after delivering substandard work."

I see. Substandard how?

"Failure to follow every step in the SOW to the letter."

Nice of you to keep us in mind after they flamed out. What if some of your new ex-vendor-inspired instructions are at cross-purposes with common sense?

"Follow them just the same. We are the customer."

Well, dear customer, your cross-section requirement for four boards, at 16 locations per board, during two cycles, involves 128 cross-sections. You're looking at a five-figure sum for that aspect of the project alone. Never mind your SOW also requires dye and pry in the same locations as cross-sectioning. That will be a bit of a problem. And we haven't even begun to discuss the scope and cost of x-ray inspection.

"Your number far exceeds our budget."

It also far exceeds your judgment.

We'll keep you in mind as a future customer.

I've always wanted to say that. ❑

State-of-the-Art Technology Flashes

Updates in silicon and electronics technology.

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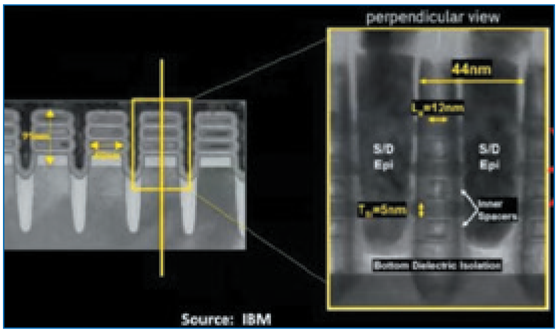
The **INTEGRATED ELECTRONICS ENGINEERING CENTER (IEEC)** at Binghamton University is a New York Center of Advanced Technology (CAT) responsible for the advancement of electronics packaging. Its mission is to provide research into electronics packaging to enhance our partners' products, improve reliability and understand why parts fail. Research thrusts are in 2.5/3-D packaging, automotive and harsh environments, bioelectronics, flexible and additive electronics, materials for packaging and energy storage, MEMS, photonics, power electronics, sensors, embedded electronics, and thermal challenges in electronic packaging. More information is available at binghamton.edu/ieec.

Ed.: This is a special feature courtesy of Binghamton University.

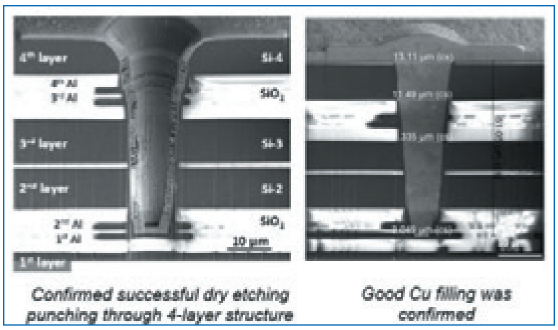
IBM announces 2nm GAA-FET technology. IBM announced its 2-nanometer CMOS technology, developed at its Albany research center. The development has technical firsts: the use of bulk Si wafers with bottom dielectric isolation under the nanosheet stack; reducing leakage and enabling 12-nnm gate lengths; a second-generation inner spacer dry process for precise gate control; FEOL EUV patterning to allow nanosheet widths from 15 to 70nm; and a novel multi-Vt scheme. This technology is expected to give a 45% performance boost or 75% power reduction, compared with the 7nm. *(IEEC file #12324, Semiconductor Digest, 6/11/21)*



Light-based method creates 2-D polymer. Linköping University researchers developed a method that uses light to manufacture 2-D polymers that have the thickness of a single molecule and could create a path for the development of ultra-thin, functional 2-D materials with highly defined crystalline structures. Using an on-surface photo-polymerization process, they tested a way to manufacture a 0.5nm-thick, 2-D polymer consisting of several hundred thousand molecules identically linked. The two-step method takes advantage of the self-organizing properties of fluorinated anthracene triptycene molecules. Because the polymerization takes place in a vacuum, the material is protected from contamination. The 2-D polymer film is stable under atmospheric conditions. *(IEEC file #12370, Photonics Spectra, 7/14/21)*

Researchers discover a new inorganic material with lowest thermal conductivity ever reported. University of Liverpool researchers have discovered a new inorganic material with the lowest thermal conductivity ever reported. This discovery paves the way for the development of new thermoelectric materials that will be critical for a sustainable society and represents a breakthrough in the control of heat flow at the atomic scale, achieved by materials design. They used complementary strategies to suppress the contribution of the longitudinal and transverse phonons to heat transport in layered materials containing different types of intrinsic chemical interface. BiOCl and Bi_2O_2Se encapsulate these design principles for longitudinal and transverse modes, respectively, and the bulk superlattice material combines these effects by ordering both interface types within its unit cell to reach an extremely low thermal conductivity of $0.1W\ K^{-1}\ m^{-1}$ at room temperature along its stacking direction. *(IEEC file #12371, Science Daily, 7/15/21)*

A*Star stacks four wafers. A*Star researchers have developed technology that can stack up to four layers of wafers using a multi-wafer fusion bonding process and a one-step TSV process, potentially decreasing the cost of production by 50%. This was made possible by combining face-to-face and back-to-back wafer bonding with one-step TSV after stacking. The 3-D integration, TSV process and multi-wafer fusion bonding technology breakthroughs will allow manufacturers to better integrate 3-D products with high added value and will mean new business opportunities with low-cost 3-D DRAM and manufacturing for device manufacturers and material suppliers. *(IEEC file #12368, Electronics Weekly, 7/8/21)*



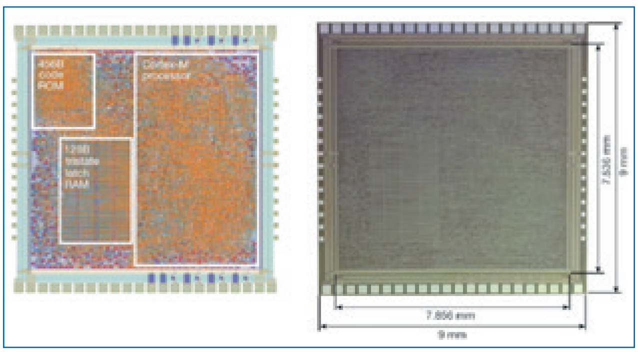
Confirmed successful dry etching punching through 4-layer structure

Good Cu filling was confirmed

IBM adopts heavy-hex lattice for quantum computing. IBM is moving all its quantum computing devices to the heavy-hex lattice topology, which promises a reduction in error rates, permitting quantum systems to overcome one of the key challenges keeping them from maximizing their potential. All IBM quantum systems will be based on this architecture, which represents the fourth iteration in the company's quantum computing topology. In a heavy-hex lattice architecture, each unit cell of the lattice consists of a hexagonal arrangement of qubits, with an additional qubit on each edge. It's scalable, which will help IBM meet its stated goal of advancing from 127 qubits in quantum computing systems this year to 1,000 qubits in 2023. *(IEEC file #12367, Fierce Electronics, 7/8/21)*

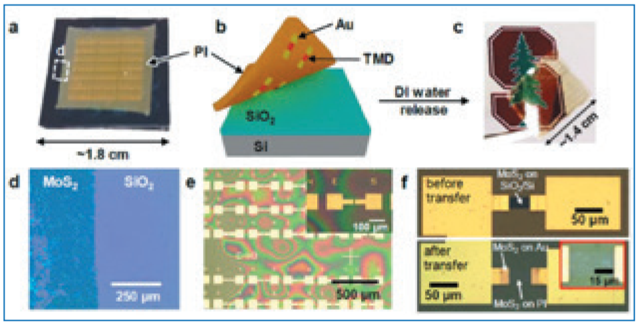
Combining perovskite with silicon solar cells converts more energy from sun. Oxford PV researchers have shown pairing metal halide perovskites with conventional silicon leads to a more powerful solar cell that overcomes the 26% efficiency limit of using silicon cells alone. Perovskites fulfill all the optoelectronic requirements for a photovoltaic cell and can be manufactured using existing processes. These features make perovskite a perfect plug-and-play addition to silicon technology, as it can be deposited as a layer onto a conventional silicon solar cell. They're proving the potential of perovskite-on-silicon tandem technology through the continuous achievement of world-record efficiencies, with the current record at 29.52%. Adding perovskite onto existing silicon photovoltaics is the fastest way to improve silicon performance. *(IEEC file #12429, Semiconductor Digest, 8/17/21)*

Researchers create flexible Cortex-M0 CPU on plastic substrate. Arm researchers have developed the first operational 32-bit microprocessor using a flexible plastic substrate instead of a brittle slab of silicon. The low-cost chip is ultra-thin and carries over 12 times as many transistors as previous flexible microprocessors. The chip called "PlasticARM" is made from metal-oxide transistors using conventional equipment manufactured on a cheap plastic substrate that permits it to bend and twist without snapping. The flexible prototype raises the possibility of embedding billions of very inexpensive, ultra-thin, form-fitting microprocessors inside clothing, labels, food packaging, and other objects. *(IEEC file #12390, Electronic Design, 7/29/21)*



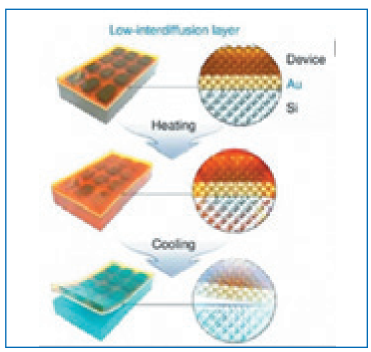
Photonic chips for fault-tolerant quantum computing. Xanadu and IMEC announced a partnership to develop the next generation of photonic qubits based on ultra-low loss silicon nitride (SiN) waveguides. Xanadu is developing a unique type of quantum computer, one based on photonics. Specifically, these photonic qubits are based on squeezed states, a special type of light generated by chip-integrated silicon photonic devices. Such an approach uses particles of light to carry information through photonic chips, rather than electrons or ions used by other approaches. Xanadu's photonic approach offers the benefits of scalability to one million qubits via optical networking, room-temperature computation, and the natural ability to leverage fabrication R&D centers. *(IEEC file #12430, Semiconductor Digest, 8/17/21)*

New fabrication approach yields high-performance flexible electronics. Stanford University researchers have devised a manufacturing approach that yields flexible, atomically thin transistors less than 100nm in length. The process is a sequence of steps that starts with a rigid base substrate of silicon coated with glass, one layer of atoms at a time, using CVD techniques. Then it's overlaid with small nano-patterned gold electrodes. These critical parts are patterned and formed on rigid silicon and permitted to cool, then applied to the flexible material. Following a bath in deionized water, the entire device stack is peeled back and transferred to the flexible polyimide. The entire structure is just 5 microns thick. *(IEEC file #12396, Science Daily, 7/29/21)*



3-D printed solid-state battery rivals lithium-ion. Lithium-ion batteries are everywhere: smartphones, laptops, and electric vehicles. Sakuu researchers are working to develop new chemistries that are lighter weight, more energy-dense, and ideally safer than today's champion technology. The next frontier is the 3-D-printed solid-state battery. Sakuu researchers have developed a solid-state battery equal to or better than the performance of current lithium-ion batteries. The technology permits the company to deposit multiple materials onto a single thin layer. To get the highest energy density batteries, they minimize the volume of all the elements that are not adding anything to the performance of the battery. That's the kind of thing that printing really enables. *(IEEC file #12434, IEEE Spectrum, 8/19/21)*

New printing technique for flexible electronics. A new technology that enables more efficient and effective transfer printing for electronic devices has been developed by researchers at DGIST in Korea. The technique could improve the manufacturing of precision devices such as biosensors and wearable devices. The printing technique makes use of the fact



that different materials expand at different rates when heated. By laying the device to be printed onto the surface to which it will be attached and then increasing the temperature, the method causes thermal stress, which creates cracks between the layers. This allows the layers to be separated successfully after printing, ensuring reliable and instant release of the device. *(IEEC file #12408, Nanowerk, 8/6/21)*

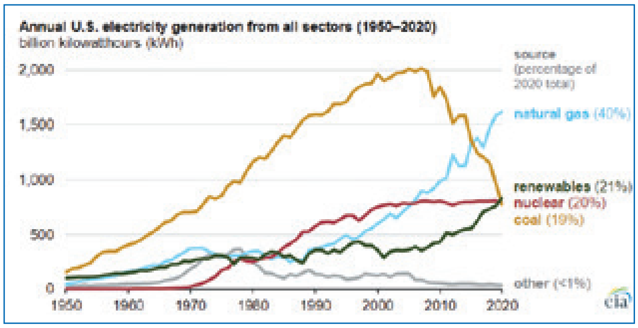
Market Trends

Microprocessor market to top $100 billion. The microprocessor (MPU) market is on track to exceed $100 billion for the first time ever this year, thanks to strong increases in cellphone application processor revenues. IC Insights projects MPU sales to increase 14% in 2021, which will lift the total microprocessor market to a record-high $103.7 billion, compared to a 9% increase that was expected in January. IC Insights is also lifting its five-year revenue forecast for microprocessors to a CAGR of 7.1%, which will put sales volume at $127.8 billion in 2025 compared to about $90.7 billion in 2020. Increasing reliance on the Internet, the pandemic resulted in a strong wave of growth in large-screen, high-end smartphones, many of them 5G handsets, which caused an upsurge of revenue for cellphone application processors in 2020. *(IEEC file #12446, Electronics Weekly, 8/26/21)*

Could all your digital photos be stored as DNA? MIT researchers have demonstrated a way to easily retrieve data files stored as DNA. This could be a step toward using DNA archives to store enormous quantities of photos, images, and other digital content. DNA is a thousandfold denser than even flash memory, and another property is DNA polymer, once made, doesn't consume energy. Hence, one can write the DNA and store it forever. Scientists have already demonstrated they can encode images and pages of text as DNA. They have now demonstrated one way to do that: by encapsulating each data file into a 6-micrometer particle of silica, which is labeled with short DNA sequences that reveal the contents. Using this approach, they could accurately pull out individual images. *(IEEC file #12333, Science Daily, 6/10/21)*

"Clinic-on-the-wrist" module enables wearable health monitoring. Rockley Photonics introduced its complete full-stack "clinic-on-the-wrist" digital health sensor system. Rockley's sensor module and associated designs for consumer products integrate hardware and application firmware to enable wearable devices to monitor multiple biomarkers, including core body temperature, blood pressure, body hydration, alcohol, lactate, and glucose trends, among others. Its full-stack sensing solution features a wristband that contains the sensor module and communicates with custom cloud-based analytical engines via smartphone app, unlike more common spectroscopy solutions, which use broad-spectrum light sources and generate a large number of discrete laser outputs from a single silicon chip covering a broad optical band. *(IEEC file #12377, BioOptics World, 7/15/21)*

Renewables accounted for 21% of US electricity in 2020. In 2020, renewable energy sources, including wind, hydroelectric, solar, biomass, and geothermal energy, generated a record 834 billion kWh of electricity, or about 21% of all the electricity generated in the US. Only natural gas (1.617 trillion kWh) produced more electricity than renewables in the United States in 2020. This outcome in 2020 was due mostly to significantly less coal use in US electricity generation and steadily increasing use of wind and solar. *(IEEC file #12406, EIA, 7/28/21)*



New manufacturing technique for flexible electronics. Stanford University researchers have invented a manufacturing technique that yields flexible, atomically thin transistors less than 100nm in length, which is several times smaller than previously possible. The technique is performed as follows: Atop a solid slab of silicon coated with glass, an atomically thin film of the 2-D semiconductor molybdenum disulfide (MoS_2) is formed and overlaid with small nano-patterned gold electrodes. Then, the layering technique (CVD) grows a film of MoS_2 one layer of atoms at a time. The resulting film is three atoms thick but requires temperatures reaching 850°C to work. With a simple bath in deionized water, the entire device stack peels back, fully transferred to the flexible polyimide. *(IEEC file #12383, Semiconductor Digest, 7/21/21)*

Wearable brain-machine interface turns intentions into actions. A new wearable brain-machine interface (BMI) system could improve the quality of life for people with motor dysfunction or paralysis, even those struggling with locked-in syndrome. Georgia Institute of Technology researchers combined wireless soft scalp electronics and virtual reality in a system that allows the user to imagine an action and wirelessly control a wheelchair or robotic arm. BMI systems are a rehabilitation technology that analyzes a person's brain signals and translates that neural activity into commands, turning intentions into actions. The non-invasive method for acquiring those signals is EEG. Future work will focus on optimizing electrode placement and advanced integration of stimulus-based EEG. *(IEEC file #12397, Science Daily, 7/21/21)*

Bike tire uses NASA shape memory alloy technology. The SMART Tire Co. is developing the first-ever consumer application of the NASA airless SMA tech. The eco-friendly bicycle tire from SMART (Shape Memory Alloy Radial Technology) is called METL. The tire is made from an advanced lightweight material called NiTinol+. This material will not corrode or rust.

The advantage is it is elastic like rubber, yet strong like titanium, exhibiting perfect shape memory without ever going flat. For now, it will serve as a real-world technology demonstrator not only for bicycles but for other possible vehicle applications in the future. *(IEEC file #12402, Design Fax, 7/27/21)*

Recent Patents

PCB assembly comprising chemical vapor CVDD wires for thermal transport (assignee: Microchip Technology), pub. no. WO/2021089974. A method and apparatus for conducting heat away from a semiconductor die are disclosed. A board assembly is disclosed that includes a circuit board, a semiconductor die electrically coupled to the circuit board, and a chemical vapor deposition diamond (CVDD)-coated wire. A portion of the CVDD-coated wire extends between a hot-spot on the semiconductor die and the circuit board. The board assembly includes a layer of thermally conductive paste disposed between the hot spot on the semiconductor die and the circuit board. The layer of thermally conductive paste is in direct contact with a portion of the CVDD-coated wire.

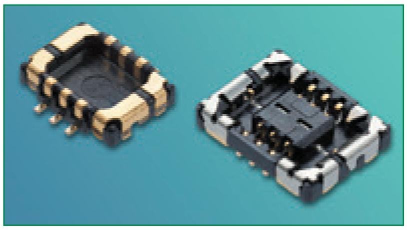
Fiber-to-chip grating coupler for photonic circuits (assignee: Taiwan Semiconductor Manufacturing), pub. no. US11002915. In one embodiment, a method for communication includes transmitting optical signals between a semiconductor photonic die on a substrate and an optical fiber array attached to the substrate using at least one corresponding grating coupler on the semiconductor photonic die, wherein at least one grating coupler each comprises a plurality of coupling gratings, a waveguide, a cladding layer, a first reflection layer and a second reflection layer, wherein the plurality of coupling gratings each comprises at least one step in a first lateral direction and extends in a second lateral direction, wherein the first and second lateral directions are parallel to a surface of the substrate and perpendicular to each other in a grating plane.

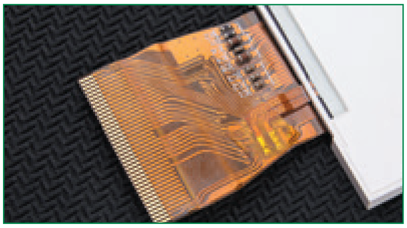
Semiconductor wafer having integrated circuits with bottom local interconnects (assignee: IBM Corp.), pub. no. US11011411. A semiconductor wafer includes a substrate. The substrate includes a first substrate region doped with a first dopant and a second substrate region doped with a second dopant. The wafer further includes a buried oxide (BOX) layer formed on the substrate and a channel layer formed above the BOX layer. A first transistor is operably disposed on the substrate in the first substrate region, and a second transistor is operably disposed on the substrate in the second substrate region. First doped source and drain structures electrically connected to the substrate in the first substrate region and separated by portions of the channel layer and the BOX layer. Second doped source and drain structures electrically connected to the substrate in the second substrate region.

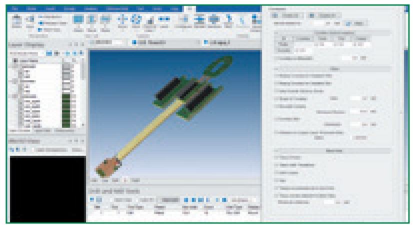
Liquid immersion-cooled electronic device and liquid immersion-cooled processor (assignee: Exascaler Inc.), patent. no. 16/612,705. A processor module includes a first circuit substrate and a second circuit substrate, each having a processor mounting area and a memory mounting area on one surface thereof. One processor is mounted in the processor mounting area, while comb-like arranged memory modules are mounted in the memory mounting area. The surface of the first circuit substrate and surface of the second circuit substrates are combined face-to-face and positioned such that the processor mounting area and memory mounting area of the first circuit substrate are face-to-face, respectively, with the processor mounting area and the memory mounting area of the second circuit substrate, and end parts of the plurality of comb-like arranged memory modules.

Crack sensor for sensing cracks in a solder pad (assignee: STMicroelectronics), patent. no. 11,018,096. An integrated circuit includes a solder pad, which includes, in a superposition of metallization levels, an underlying structure formed by a network of first regular metal traces that are arranged to reinforce the mechanical strength of the underlying structure and electrically connect between an upper metallization level and a lower metallization level of the underlying structure. The underlying structure further includes a detection electrical path formed by second metal traces passing between the first metal traces in the metallization levels, the detection electrical path having an input terminal and an output terminal. Electrical sensing of the detection electrical path is made to supply a measurement that is indicative of the presence of cracks in the underlying structure.

Cooling system for power modules (assignee: Delta Electronics), pub. no. EP3833171. The cooling system includes two covers: a plurality of power modules and a plurality of first spaces. The power modules are disposed between the two covers. Each power module includes a housing, a circuit board, and heat dissipation elements disposed on the two sides of the circuit board. A through-hole is on the housing. Each first space is formed between two neighboring power modules and the neighboring power module. The heat dissipation elements of each power module are located in the neighboring first spaces, and the through-hole of each power module is in communication with the neighboring first spaces. The first spaces and the through-holes of the power modules communicate with each other to form a coolant passageway collaboratively for permitting a coolant to pass through. □







MOLEX 5G25

Flex-to-Board RF mmWave connector 5G25 meets 5G mmWave applications requiring signal integrity at higher frequencies up to 25GHz. Micro connector enables optimization of high-speed 5G components, while alleviating space constraints. Supports high-speed data transmission; offers protection from harsh environmental conditions. Features signal pitch of 0.35mm, mated body height of 0.6mm, body width of 2.5mm and length of 3.6mm. Combines RF and non-RF signals.

Molex

molex.com

SABIC SD1100P

SD1100P high-purity dianhydride powder for polyimide films is for use in 5G flexible circuits, colorless displays and other flexible electronics applications. This 4,4'-bisphenol A dianhydride powder helps produce high molecular weight PI formulations that can improve balance between thermal and mechanical properties. Features lower Dk and Df, reduced water absorption and improved metal adhesion for creating films and varnishes used in copper-clad laminates, coverlays and adhesives.

Sabic

sabic.com

DOWNSTREAM CAM350 V. 14.6

CAM350 v. 14.6 includes enhanced support for flex/rigid-flex and embedded component visualization in 2-D and 3-D environments. Upgrades DfM analysis capability to support rigid-flex and inter-layer analysis. Rigid-flex analysis focuses on flexible conductive layers and coverlayers. Analyzes flexible trace layers for conditions that potentially lead to trace fracture such as vias, trace corners, or solid copper areas in bend areas.

DownStream Technologies

downstreamtech.com

OTHERS OF NOTE

VISHAY DRALORIC RCV-AT E3

Draloric RCV-AT e3 thick-film chip resistors are AEC-Q200-qualified and have operating voltages up to 3kV in 2010 and 2512 case sizes. Reportedly can be used in place of standard resistor chains. Feature resistance range from 100kΩ to 100MΩ, with tolerances of ±1% and ±5% and TCR of ±100 ppm/K and ±200 ppm/K. Offer power ratings up to 1.0W, voltage coefficient of resistance of 25 ppm/V, and operating temp. range of -55° to +155°C. RoHS-compliant and halogen-free. Are suitable for processing on automatic surface-mount assembly systems and for wave, reflow, or vapor phase soldering per IEC 61760-1.

Vishay

vishay.com

AVX AHC SERIES

AHC series SMT hybrid electrolytic aluminum capacitors are available in five case sizes: 0608, 0609, 0810, 0812, and 1010. Capacitance values and voltage ratings span 15-470µF and 25-80VDC. Are rated for operating temp. extending from -55° to +125°C, exhibit ultra-low ESR and high ripple current resistance, reliably withstand 4,000 hr. at 125°C, and are well suited for use in commercial and industrial power supplies that require high capacitance in energy-dense, small-volume packages.

AVX Corp.

avx.com

DOWNSTREAM BLUEPRINT-PCB V. 6.6

BluePrint-PCB documentation tool v. 6.6 includes 2-D graphic upgrade and capability to transfer BluePrint panel document into CAM350 for panel design editing.

DownStream Technologies

downstreamtech.com

VISHAY IHLP 7575GZ-51

IHLP 7575GZ-51 low-profile, high-current composite inductor comes in 19 x 19 x 7mm 7575 case size. Offers temp. operation to +155°C for computer, telecom, and industrial applications, up to 30% lower DCR and up to 35% higher current ratings than devices in 6767 case size. Is optimized for energy storage in DC/DC converters up to 2MHz and high current filtering applications up to SRF of inductor. Packaged in 100% Pb-free shielded composite construction that reduces buzz noise to ultra-low levels. Offers resistance to thermal shock, moisture, and mechanical shock; handles transient current spikes without saturation. Is RoHS-compliant, halogen-free and Vishay Green.

Vishay

vishay.com

INTROSPECT PV2 UNIVERSAL ACTIVE PROBE

PV2 Universal Active Probe 8GHz in-system measurement system is for parallel, single-ended, wireline interfaces powering next-generation digital systems. Is built around multiple parallel interfaces that connect central processing elements with different memory, sensing, and data aggregation elements. Ideal for probing full-width parallel wireline interfaces such as those found in DDR5 and LPDDR5 system implementations, as well as MIPI Alliance CSI-2SM or DSI-2SM system implementations.

Introspect Technology

introspect.ca

MATHWORKS MATLAB 2021B

Matlab 2021b includes code refactoring and block editing, as well as the ability to run Python commands and scripts. New products support wireless communications: RF PCB Toolbox enables design, analysis, and visualization of high-speed and RF multilayer PCBs. RF engineers can design components with parameterized or arbitrary geometry, including distributed passive structures such as traces, bends, and vias. Using frequency-domain method of moments and other EM techniques, coupling, dispersion, and parasitic effects can be modeled. Toolbox support for ODB++ and databases from Allegro, Xpedition, Altium, and Zuken enable analysis of high-speed portions of PCB layout.

MathWorks

mathworks.com

VISCOM IX7059 XL

iX7059 Heavy Duty Inspection XL offers rapid handling of inspection objects weighing up to 40kg and 3-D AXI with powerful radiation. Handles encased components and power electronics requirements. Extended longboard option for PCBAs measuring up to 1600 mm.

Viscom
viscom.com

KOH YOUNG MEISTER D+ TRUE3D

Meister D+ True3D inspection system inspects solder paste, printed bumps, solder balls, components down to 0201M (008004), and die with 10µm bump height and 5µm gap spacing using eight-projector probe. Performs MCM/SiP/chiplet inspection with integrated measurement and defect analysis software built on AI engine. User-friendly GUI and programming wizards. IPC-CFX-2591, IPC-HERMES-9852, and IPC-DPMX-2581 compatible.

Koh Young
kohyoungamerica.com

MEK ISO-SPECTOR M2

ISO-Spector M2 inline 3-D AOI has redesigned chassis; accommodates larger boards (510mm x 460mm), including optional angular camera in smaller footprint. Conveyor system with pneumatic drives reduces handling times 27%. High-res 25MP camera with advanced lens optics, FoV of 69mm x 69mm and 4x multi-frequency Moiré projectors.

Mek (Marantz Electronics)
marantz-electronics.com

OTHERS OF NOTE

KNS IFLEX

iFlex placement machine includes new XT placement head with side-view camera system for vision on the fly and component heights of 21 to 21mm; larger touch-screen monitors; new SlimFit feeder system with up to 126 spaces for 8mm component rolls; improved framework and safety concept; powerful system controller with latest Windows operating system.

Kulicke & Soffa
kns.com

OMRON VT-S10

VT-S10 series 3-D AOI uses multi-direction, multi-color imaging, MPS 3-D hardware and AI to reduce false calls, improve first-pass yields and optimize defect detection. Combines advanced illumination, sophisticated image processing and full 3-D measurement data to yield high-quality solder inspection. Shadow and secondary reflection impacts common to 3-D AOI reportedly are eliminated through new hardware developments like quad multi-phase shift projectors that allow stable inspection across PCBA.

Omron Automation
automation.omron.com

MACDERMID ALPHA WS-826

Alpha WS-826 water-soluble solder paste is designed to provide excellent environmental stability in extreme operating conditions. Offers 8-hr. stencil life at elevated temperatures and humidity levels and excellent solderability. Provides consistent stencil life, tack time and print definition. Pb-free, zero-halogen paste reflows in air and nitrogen. For defense, aerospace, communications, computing and medical applications.

MacDermid Alpha Electronics Solutions
macDermidalpha.com

JUKI JM-50

JM-50 SMT placement machine uses Takumi placement head, which automatically adjusts its height to provide optimal speed and component handling simultaneously. Up to four nozzles pick at same time. Laser and vision inspection for leads and body of component, and lead correction unit straightens and corrects bent leads. Nozzle types include vacuum, axial, gripper and mini chuck. Handles radial, axial, stick, bowl, tray and SMT tape feeders. MVF feeder handles bulk components.

Juki
jukiamericas.com

SCIENSCOPE SMART STORAGE RACK

Smart Storage Rack stores electronic components and can be integrated with component counter and IMS systems or desktop reel scanner. Provides accurate inventory with unique ID number and exact location. Is built with stainless steel and ESD caster. Free ERP and MES system integration with auto slot assignment by LED light. Stores 1,400 7" reels or 480 13" reels. Customization optional.

Scienscope
scienscope.com

KOH YOUNG MEISTER D+ TRUE3-D INSPECTION SYSTEM

Meister D+ True3-D inspection system is for chiplets and system-in-package devices, including die and surface mount components. Inspects solder paste, printed bumps, and solder ball to small components like 0201Ms and highly reflective die. Is for component and die inspection, while delivering accurate inspection from eight-projector probe. Targets MCM/SiP/chiplet inspection with integrated measurement and defect analysis software built on AI engine. Beyond 0201M (008004) microchips, 10µm bump height, and 5µm gap spacing, it detects die defects like micro-cracks, chippings, and foreign material. Supports missing, offset, rotation, polarity, dimension, and co-planarity. Has Moiré technology, 12mp/5µm optics, and 300mm^2/sec. inspection speed. User-friendly GUI and programming wizards. IPC-CFX-2591, IPC-HERMES-9852, and IPC-DPMX-2581 compatibility.

Koh Young
kohyoungamerica.com

KULICKE & SOFFA IFLEX PLACEMENT MACHINE

iFlex placement machine includes new XT placement head with side-view camera system for vision on the fly and component heights of 21 to 21mm; larger touch-screen monitors; new SlimFit feeder system with up to 126 spaces for 8mm component rolls; improved framework and safety concept; powerful system controller with latest Windows operating system.

Kulicke & Soffa
kns.com

SEHO LEANSELECT-PLUS SELECTIVE SOLDERING SYSTEM

LeanSelect-plus selective soldering system is for lean production island manufacturing. Is 7 sq. m. and can be expanded with additional modules. Assemblies are loaded and unloaded via two separate transports on the front; can be integrated into manual operation with transverse conveyor, individualized, semi-automatic workstation, or into a fully automated production line with several workstations. Workstations are integrated in counterclockwise U-shape. All process steps are fully automated and continuously monitored. Fluxers, preheat stations, soldering units and additional processes such as cooling station, selective brushing unit for automatic soldering point cleaning, as well as PowerVision AOI system for THT processes, can be integrated. Precision micro-drop jet fluxer reportedly ensures flux is applied accurately. Provides automatic flux quantity monitoring and automatic position correction via fiducial recognition. Gradient-controlled preheating process takes place at up to two stations with quartz or energy-efficient pulsar emitters. Convection modules can be integrated as top heating. Has electromagnetic soldering units equipped with mini wave nozzles or multi-nozzle tools. Is suited for LongLife soldering nozzles. Uses SmartSplit software that controls and coordinates process flow for different assemblies in mixed operation. Functions include automatic wave height control and tool measurement, automatic z-value correction and monitoring of nitrogen quality.

Seho Systems
seho.de/en/

LACKWERKE PETERS ELPEMER SOLDER RESIST

Elpemer solder resist is now available in red, blue and black. Can be exposed conventionally and with direct imaging process. UL 94 certification attests highest safety level V-0 with respect to flammability. Self-extinguishing and does not continue to burn after removal of test flame. Does not contain photoinitiators types 907 and 369.

Lackwerke Peters
peters.de

KOH YOUNG NEPTUNE C+ DISPENSE PROCESS INSPECTOR

Neptune C+ True3-D inline dispense process inspector has laser interferometry for fluid tomography. Delivers nondestructive 3-D inspection to measure wet/dry fluids, including material thickness at production speeds. Based on low-coherence interferometry, LIFT employs near-infrared light to capture images through multiple layers of fluidic structure regardless of transparency. Has integrated flipper, intuitive programming, and machine-learning algorithms. Uses 2-D, 3-D, and cross-section views to identify defects at production speed. With advanced algorithms to teach inspection parameters, it measures materials for coverage, thickness, and consistency using user-defined threshold setting. Inspects bubbles, cracks, and other defects, even keep-out areas with 50µm splash marks. Besides coatings, it measures underfill, epoxy, and bonding. Currently suited for acrylic, silicone, polyurethane, water-based, UV-cure, and hybrid coatings.

Koh Young
kohyoungamerica.com

SCIENSCOPE SMART STORAGE RACK

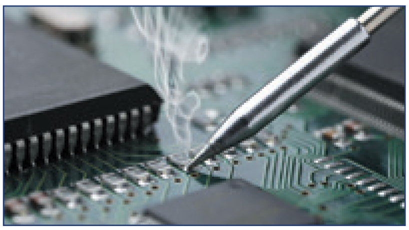
Smart Storage Rack stores electronic components and can be integrated with component counter and IMS systems or desktop reel scanner. Provides accurate inventory with unique ID number and exact location. Is built with stainless steel and ESD caster. Free ERP and MES system integration with auto slot assignment by LED light. Allows for 1,400 7" reels or 480 13" reels to be stored. Optional customization.

Scienscope International
scienscope.com

SHENMAO INTRODUCES PF606-P245X SOLDER PASTE

PF606-P245X solder paste has wide reflow window. Can fit into process of complicated PCB designs. Special alloy design improves electronics assembly product life. Developed for high-speed network and communication applications. Provides long-term stability over wide range of temperature conditions. No-clean paste provides consistent printing performance, low voiding, stable viscosity life, and excellent testability.

Shenmao
shenmao.com



ULT LAS 800 EXTRACTION SYSTEM

LAS 800 extraction system removes large quantities of the finest particles and gases produced during laser processing of metals, plastics, and other nonmetallic materials. Is among quietest systems in its class, has long filter service life, and simple installation and maintenance options.

Ult
ult.de

ASM DEK TQ STENCIL PRINTER

DEK TQ high-volume screen printer has core cycle time of as little as 5 sec. and wet printing accuracy of up to 17µm @6Σ. New options offer more flexibility and adjustability, including All Purpose Clamping (APC), a universal flexible clamping system; Smart Pin Placement, for the automatic placement of various-size pins with integrated position and height check; and the Dual Access Cover, for interruption-free replacement of paste dispensers.

ASMPT
asm-smt.com

OMRON VT-S10 3-D AOI

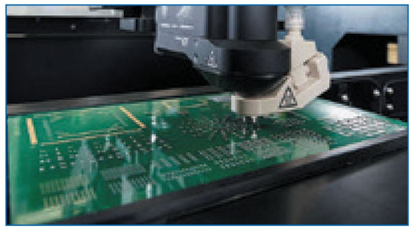
VT-S10 series 3-D AOI uses multi-direction, multi-color imaging, MPS 3-D hardware and AI to reduce false calls, improve first-pass yields and optimize defect detection. Combines advanced illumination, sophisticated image processing and full 3-D measurement data to yield high-quality solder inspection. Shadow and secondary reflection impacts common to 3-D AOI reportedly have been eliminated through new hardware developments like quad, multi-phase shift projectors that allow for stable inspection across PCBA. Designed with 5-Zero philosophy: zero PCB design constraints; zero false calls and escapes; zero operation and programming; zero downtime; zero defects.

Omron Automation Americas
automation.omron.com

JUKI JM-50 SMT PLACEMENT MACHINE

JM-50 SMT placement machine uses Takumi placement head, which automatically adjusts its height to provide optimal speed and component handling simultaneously. Can pick with up to four nozzles at the same time. Uses JaNets line control software. Laser and vision inspection permits inspection of leads and body of component, and lead correction unit straightens and corrects bent leads. Multiple nozzle types available, including vacuum, axial, gripper and mini chuck. Handles radial, axial, stick, bowl, tray and SMT tape feeders. MVF feeder can handle bulk components.

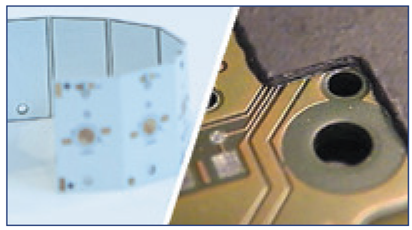
Juki
jukiamericas.com



ESSEMTEC ARCHERFISH SOLDER PASTE JETTER

Archer Fish solder jet dispenser has a VDST valve to jet solder paste for components 01005 (0.4mm pitch) up to 0402. Has freely selectable and combinable settings of jet parameters for optimal adaptation to customer requirements and characteristics of the dispensing material. Dynamic shockwave technology allows it to jet several hundred shots within just a second with high accuracy and repeatability.

Essemtec
essemtec-usa.com



LACKWERKE PETERS ELPEPCB HEATSINK PASTE HSP 4 A

ELPEPCB heatsink paste HSP 4 A printed thermal conductive pastes distribute heat on surface as heatsink.

Lackwerke Peters
peters.de

PVA DELTA 8 SELECTIVE CONFORMAL COATING MACHINE

Delta 8 selective conformal coating machine now includes 5th axis motorized tilt, a motorized programmable tilt that can be configured to adjust to any angle between -45° to 45°. Allows greater part accessibility. Delta 8 is ideal for selective coating, potting, bead, and meter-mix dispensing applications. Features robotic system repeatability of +/-25µm; servo-controlled optional four-axis motion featuring valve tilt and rotate; closed-loop process control throughout gantry system; multiple dispensing applications or materials in one cell; onboard PC for unlimited program storage; PathMaster programming environment.

PVA
pva.net

In Case You Missed It

Computer Memory

"Ultralow-Switching Current Density Multilevel Phase-Change Memory on a Flexible Substrate"

Authors: Asir Intisar Khan, *et al.*

Abstract: Phase-change memory (PCM) is a promising candidate for data storage in flexible electronics, but its high switching current and power are often drawbacks. In this study, the authors demonstrate a switching current density of ~0.1MA per sq. cm. in flexible superlattice PCM, a value that is one to two orders of magnitude lower than in conventional PCM on flexible or silicon substrates. This reduced switching current density is enabled by heat confinement in the superlattice material, assisted by current confinement in a pore-type device and the thermally insulating flexible substrate. The authors' devices also show multilevel operation with low-resistance drift. The low switching current and good resistance on/off ratio are retained before, during, and after repeated bending and cycling. These results pave the way to low-power memory for flexible electronics and provide key insights for PCM optimization on conventional silicon substrates. (*Science,* Sept. 10, 2021, https://www.science.org/doi/10.1126/science.abj1261)

Counterfeit Detection

"Deterministic Tagging Technology for Device Authentication"

Authors: Jungjoon Ahn, Joseph Kopanski, Yaw S. Obeng and Jihong Kim

Abstract: This paper discusses the development of a rapid, large-scale integration of deterministic dopant placement technique for encoding information in physical structures at the nanoscale. The doped structures inherit identical and customizable RF electronic signature, which could be leveraged into an identification feature unique to the tag item. This will permit any manufactured item (e.g., an IC) to be uniquely identifiable and authenticatable. Applications of this technology include enabling a secure IoT and eliminating counterfeit products. (International Conference on IC Design and Technology, September 2021, https://www.nist.gov/publications/deterministic-tagging-technology-device-authentication)

This column provides abstracts from recent industry conferences and company white papers. Our goal is to provide an added opportunity for readers to keep abreast of technology and business trends.

Soldering Reliability

"Effects of Ag Flake Addition in Sn-3.0Ag-0.5Cu on Microstructure and Mechanical Properties with High-Temperature Storage Test"

Authors: Jun-Ho Jang, *et al.*

Abstract: In the 3-D IC package industry, remelting of solder joints during repeated stacking processes can cause electrical failure and low bonding strength. Transient liquid phase sintering (TLPS) bonding based on forming full intermetallic compounds (IMCs) in the solder joint to increase the remelting point has emerged as a potential solution to this issue. Here, pressureless TLPS Cu-Cu bonding was conducted with Sn-3.0Ag-0.5Cu solder powders and various Ag flake powder content (15 wt.%, 30 wt.%, 45 wt.%, and 60 wt.%). The TLPS paste was screen-printed, and the bonding process was conducted at 255°C for 2 hr. in an air atmosphere without bonding pressure. Additionally, this study investigated the microstructural evolution and fracture modes of the TLPS joints after the shear tests were investigated. High-temperature storage tests were conducted at 300°C for 24 hr., 48 hr., and 96 hr., and a shear test was then performed to evaluate bonding strength. A differential scanning calorimetry (DSC) analysis of the TLPS paste was conducted to investigate the thermal behavior of the paste during the bonding process. No residual solder was found in TLPS joints with an Ag flake content above 45 wt.% The highest bonding strength in a TLPS joint with full IMC layers was 27.3 MPa, representing an approximate 9% decrease after 96 hr. of high-temperature storage test. TLPS bonding with an optimal composition was resistant to the remelting of solder joints due to the full IMC layers; i.e., it represents a reliable interconnection method for 3-D stacking. (*Journal of Electronic Materials,* July 2021, https://link.springer.com/article/10.1007/s11664-021-09102-4)

Others of Note

What if your smartphone or laptop started charging as soon as you walked in the door? Researchers have developed a specially built room that can transmit energy to a variety of electronic devices within it, charging phones and powering home appliances without plugs or batteries. (www.scientificamerican.com/article/this-room-could-wirelessly-charge-all-your-devices)

Michigan Technological University researchers have created a way to make a 3-D-printable nanocomposite polymeric ink that uses carbon nanotubes (CNTs), a method that could supplant epoxies. (www.eurekalert.org/news-releases/929545)

UCLA researchers observed that a soft magnetoelastic composite can be used for stretchable and water-resistant magnetoelastic generators, adhering conformably to human skin. Such devices can be used as wearable or implantable power generators and biomedical sensors, opening alternative avenues for human-body-centered applications. (www.nature.com/articles/s41563-021-01093-1)