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A RoHS RECAST

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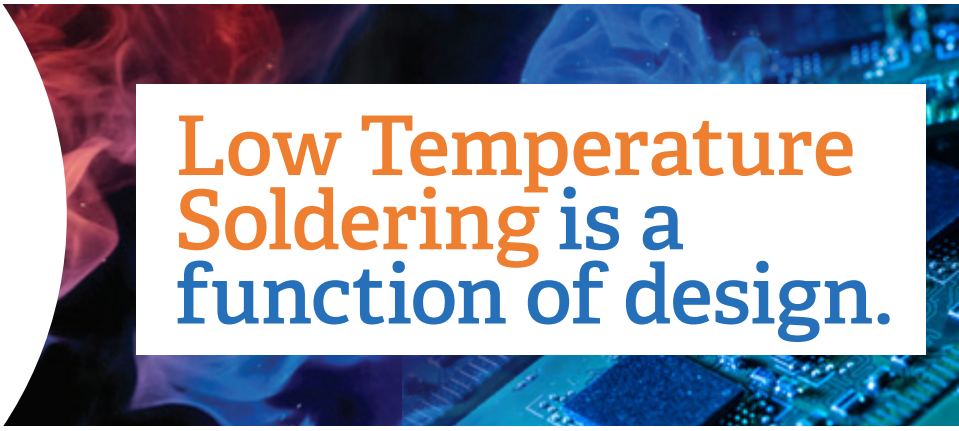

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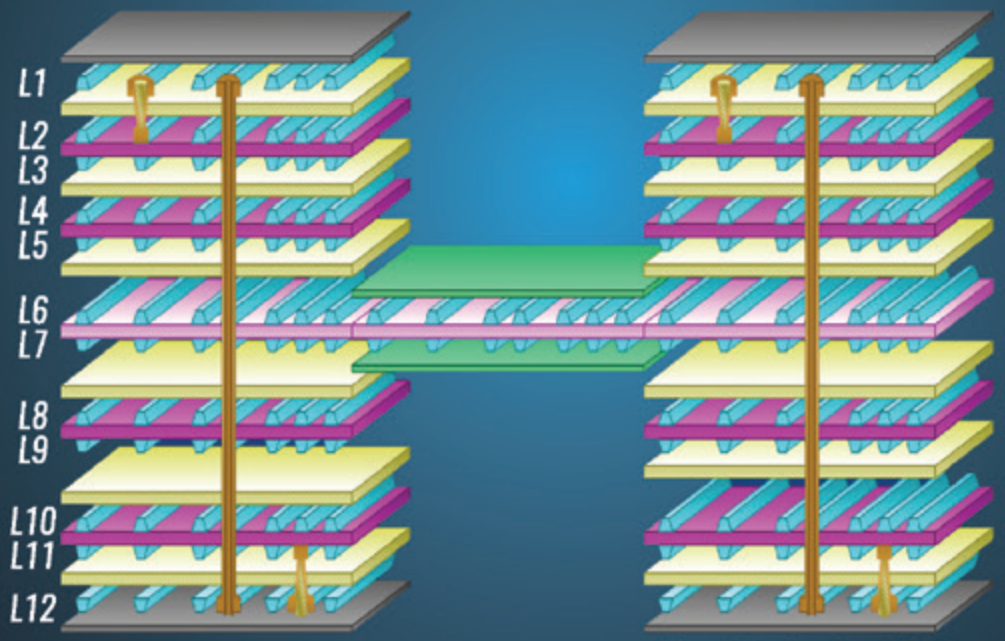

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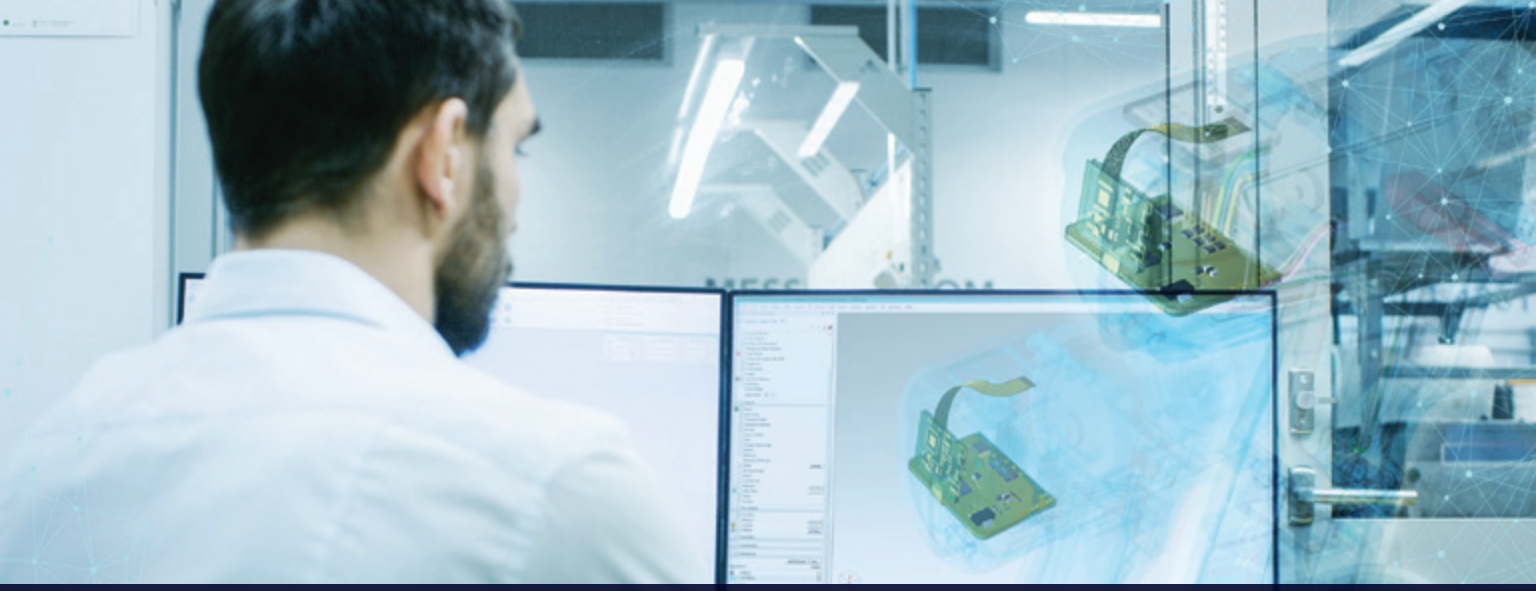

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Going in Circles, or WEEE Don't Need No Regulation

MORE THAN 15 years ago, the Restriction of the Use of Hazardous Substances in Electronics (RoHS) went into effect with great fanfare. While it had far-reaching effects, the most prominent material affected was lead.

Lead has for decades been the industry's bad boy. (I'd say red-headed stepchild, but I am still mostly red-headed.) Several attempts were made in the US alone to eliminate its use, and the remediation and eradication efforts for lead in plumbing has had a pronounced effect on lowering rates of birth defects and learning disabilities. While an EU mandate, RoHS had a ripple effect throughout electronics-producing regions, and most eventually migrated to using lead-free materials in electronics solder as well.

As the early RoHS end-use exemptions expired, the number of electronics hardware applications using lead has become limited primarily to legacy high-reliability programs. One of the last holdouts has been the US Department of Defense, and even that pendulum is swinging. The last few US defense appropriations bills have included millions of dollars in funding to support the transition of various aerospace, defense and high-performance electronics to lead-free technologies.

But as we focus on the molecules, are we missing the larger compound? By that I mean the ability to recycle and reuse the materials in electronics products, regardless of their relative toxicity?

Michael Kirschner, president of Design Chain Associates, thinks so. As he explained to PCEA chief content officer Chelsey Drysdale in March on the PCB Chat podcast, many of the directives and regulations, while well-meaning, have fallen short of their ultimate goals, which was to change manufacturer behavior. And yet it is manufacturer behavior that must change if the needle is to be moved. After all, it's been years since the packaging containing electronics came adorned with the green lead-free labels that signified to consumers they had a choice to buy eco-friendly products.

Born about five years prior to RoHS, the Waste Electrical and Electronic Equipment Regulation (WEEE) directive mandates electronics recycling. Compliance rates, however, have been stubbornly low. The percentage of e-waste that's properly recycled hovers around 40% per European Commission data, well below targets.

According to Kirschner, manufacturers have been reluctant to change their ways. "Fundamentally, we're still using the classical linear product lifecycle process to design products and manufacture them. And really, manufacturers haven't made changes to process or design to products to make them more recyclable or more reusable. They've just paid the amount of money the recyclers and member states are asking and said, 'OK, it's your problem now.'"

Last month, the EU held an open comment period for the next revision of RoHS. One possibility, says the EU, is merging RoHS with the EcoDesign directive, also known as 2009/125/EC.

Kirschner thinks the EU will try to bring RoHS into alignment with the Circular Economy Action Plan (CEAP). The circular economy serves as a more holistic way of addressing environmentally sound recovery and disposal of waste, including electronics. In real terms, per the US EPA, the circular economy aims to eliminate waste through "superior design" of materials, products and systems, including business models.

Says Kirschner: "I think they're going to try to tie this all together to be more sensible and coherent, rather than have RoHS, REACH, EcoDesign, Persistent Organic Pollutant (POPS) – all these different regulations impacting one aspect or another of the electronic product and the design of that product. I don't know how they plan to make it more coherent, but I certainly expect to see changes to a regulation that simply bans substances like RoHS to make it more circular."

Likely, changes are coming. While Europe has often worked past deadlines for new publications, the European Commission says the RoHS revision is expected by the fourth quarter of this year. Industry can and should coordinate coherent feedback to ensure any changes are actionable and effective.

RoHS brought many changes to material systems, in particular ramped use of tin-silver-copper, high-tin and tin-bismuth alloys, among others. In many cases, the changeover revealed improved performance that might never have been noticed had assemblers not been forced to switch.

But we must also take measures to ensure our own product designers understand the novel materials available that might not only be equal to or better than the current crop in performance but also recyclability. And those same designers must have access to best-in-class information on how to, you know, design products that can be reused.

Those interested in moving forward – or should that be moving in circles? – would be wise to consider PCB East (pcbeast.com), coming April 11-13 to Marlboro, MA. Bump elbows with those at the leading edge of technology development. We'd love to see you there. ▫

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PCDF People

Nicolas Chaillan, former chief software officer of the US Air Force and Space Force, will deliver the keynote address for Zuken Innovation World Americas, slated for June 6-9 in San Antonio.

Isola hired **Jim Francey** as RF business development director, Europe. He has more than 30 years of high-frequency industry experience in chemistry and PCB materials and development engineering with Optiprint, Taconic and AlliedSignal.

NCAB Group announced the departure of Elmatica CEO **Didrik Bech.**

Sandia National Labs named **Randy Bossi** product design engineer-ECAD librarian.

Siemens named **Stephen Chavez** senior product marketing manager. He spent the previous 11 years as principal engineer, SME PCB Design at Collins Aerospace.

PCDF Briefs

Altair has acquired **Powersim,** a provider of simulation and design tools for power electronics, including power supplies, motor drives, control systems, and microgrids, and **Cassini,** a cloud native technology for Industry 4.0.

Altium 365 has successfully completed its service organization control (SOC) 2 Type 1 compliance certification.

Averatek added **TEC Associates** as manufacturers' representative.

Cadence Design Systems and **Dassault Systèmes** have combined Dassault Systèmes' 3DExperience platform with Cadence Allegro PCB design software to enable multidiscipline modeling, simulation and optimization of connected electronic systems.

Cicor Asia moved to a new facility in Woodlands, Singapore, which will serve as the fabricator/EMS company's headquarters.

NCAB Group halted all deliveries of PCBs to Russian customers, effective immediately.

Nexar, a business unit of **Altium,** launched Spectra electronics industry data intelligence products to help businesses better anticipate supply chain challenges and opportunities, and respond to changing market conditions.

PCB East Offers Free Sessions on DDR Memory Layout, Flex Circuits and Fab Concerns

PEACHTREE CITY, GA – PCB East will offer a full day of free classes during its annual technical conference and exhibition in April in Marlborough, MA.

The technical conference takes place April 11-13, with the Free Tuesday sessions on April 12, the same day the exhibition is open.

A highlight of the free sessions is a presentation from noise control expert Rick Hartley on PCB layout of DDR bus structures. Hartley's presentation will focus on identifying reasonable rules and guidelines, as well as proper PCB layout concepts to ensure DDR structures function as intended without adding extra time or cost to the project.

Ray Fugitt and David Hoover bring their ever-popular look at the 21 most common design errors caught by fabrication from PCB West to the East Coast this year. The lively two-hour session looks at each error and discusses ways to find them before the designs are sent out for manufacturing.

In a special free two-hour class, two of the most recognized names in the flexible circuit industry – Mark Finstad (co-chair of IPC-2223) and Nick Koop (co-chair of IPC-6013) – cover the entire gamut of flexible and rigid-flex circuits from mechanical design/material selection, cost drivers, bending and forming concerns, testing, and issues unique to rigid-flex. The course includes a complete virtual plant tour of a flexible circuit manufacturing facility.

Capping off the free sessions is the keynote from international electronics industry consultant Gene Weiner, who will offer a look at several emerging developments in additive manufacturing, materials, equipment, components and other areas that could change the design-to-manufacturing process over the next few years.

"Nowhere else will printed circuit engineers have access to such a lineup of experts, in person and for free," said Mike Buetow, president of PCEA and conference director, PCB East. "You will kick yourself if you miss it."

For information on the technical conference and to register for PCB East, visit https://pcbeast.com.

Industry Leaders Foster Open Ecosystem for Chiplet-Based Design

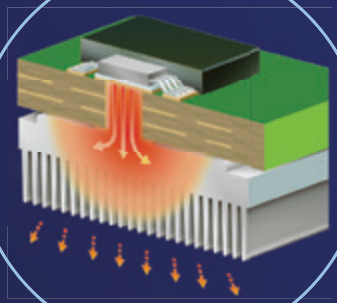
SANTA CLARA, CA – Intel, Advanced Semiconductor Engineering and Taiwan Semiconductor Manufacturing, among others, have formed a consortium to establish a die-to-die interconnect standard and foster an open chiplet ecosystem. The new group will promote an open die-to-die interconnect standard called Universal Chiplet Interconnect Express (UCIe).

Intel developed the UCIe standard and donated it to the group of founding members as an open specification that defines the interconnect between chiplets within a package, enabling an open chiplet ecosystem and ubiquitous interconnect at the package level.

"Integrating multiple chiplets in a package to deliver product innovation across market segments is the future of the semiconductor industry and a pillar of Intel's IDM 2.0 strategy," said Sandra Rivera, executive vice president and general manager of the Datacenter and Artificial Intelligence Group at Intel. "Critical to this future is an open chiplet ecosystem with key industry partners working together under the UCIe Consortium toward a common goal of transforming the way the industry delivers new products and continues to deliver on the promise of Moore's Law."

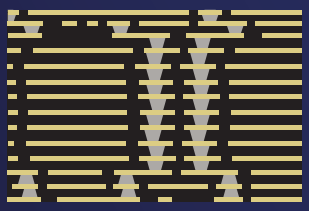
The chiplet ecosystem created by UCIe is a critical step in the creation of uni-

Via Filling Solutions



Thermal Release

Conductive/Non-Conductive Paste AE Series are long selling products for PCB/substrate thermal release. The pastes are filled into vias of PCBs/substrates by screen printing. Solvent free Tatsuta original formulation enables void less via filling with excellent long hour workability.



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This image shows circuitry formed with SW series on glass substrate.

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NextFlex released a call for proposals that seek to fund projects that further the development and adoption of flexible hybrid electronics, while addressing challenges in advanced manufacturing and supporting **Department of Defense** priorities.

NI announced the opening of its Engineering Innovation Centre (EIC) in Bangalore. The engineering lab, which opened late 2021, supports NI's customers, partners and startup companies that serve the local aerospace and defense market.

TTM Technologies will invest $130 million in a state-of-the-art, automated board manufacturing facility in Penang, Malaysia.

CA People

Flex named **Becky Sidelinger** president, Reliability Solutions. She has over three decades' experience in Fortune 100 industrial organizations.

MicroCare Asia appointed **Emma Chen** regional sales manager.

Zestron named **Aun Hua Yeo** executive director, South Asia.

CA Briefs

Benchmark Electronics has invested in new optical integration, photonics packaging, and photonics test capabilities at its RF and Photonics Center of Innovation in Phoenix.

An Indian regulatory agency has approved **Elin Electronics** for an initial public offering.

Europlacer enjoyed growth of 49% in orders, along with a 33% increase in sales billings in 2021.

Foxconn and **Luxshare Precision** are possible candidates to produce the rumored **Apple** Car.

Kyocera AVX is set to acquire **Rohm Semiconductor's** tantalum and polymer capacitor business assets for an undisclosed sum. The transfer is scheduled to be executed on Aug. 5.

Mirtec named **Techsystems** its Manufacturers' Representative Organization of the Year for 2021.

Murata will acquire all outstanding shares of **Resonant** not owned by Murata for $4.50 per share in cash.

fied standards for interoperable chiplets, which will ultimately allow for the next generation of technological innovations. For more about the UCIe consortium, visit uciexpress.org.

Cisco Talos Researchers Find Security Flaws in PCB Viewer

SAN JOSE – Cisco's Talos Intelligence Group outlined six critical-severity vulnerabilities affecting Gerbv, the open-source file viewer for printed circuit board designs.

The investigators found a so-called "out-of-bounds read vulnerability" in the RS-274X aperture macro multiple outline primitives functionality of Gerbv 2.7.0, Gerbv forked 2.7.1 and 2.8.0. Hackers could exploit this vulnerability to access the contents of Gerber files.

An attacker could reach the software over the network without user interaction or elevated privileges.

"Some PCB manufacturers use software like Gerbv in their web interfaces as a tool to convert Gerber (or other supported) files into images. Users can upload Gerber files to the manufacturer website, which are converted to an image to be displayed in the browser, so users can verify what has been uploaded matches their expectations," the report said.

Gerbv is a native Linux application and is used on UNIX and Windows platforms. It is used to view Excellon drill files, Gerber RS-274X files and pick-and-place files.

While patches have been released for four of these vulnerabilities, two flaws remain unpatched more than 90 days since the vendor was notified, Talos said.

Upcoming Webinar to Explain DDR Memory Layout

PEACHTREE CITY, GA – Rick Hartley in June will present a special webinar on layout of DDR memory. PCEA produces the webinar, and registration is at pcb2day.com.

Says Hartley: "The majority of today's digital systems utilize double data rate (DDR) memory. The advantages are many, mostly that we get twice the amount of information transfer per given 'clock frequency.' More data transfer without increased signal integrity or EMI risk: Fabulous!

"Over the years, guidelines and rules have been developed, attempting to ensure DDR bus structures function as intended. Unfortunately, many rules are overly conservative and require excessive restrictions in PCB layout, adding time and cost to PCB design. Worse, these restrictions can add layers and cost to the PCB itself."

Proper PCB Layout – DDR2, 3, 4, etc. – will focus on identifying reasonable rules and guidelines, as well as proper PCB layout concepts to ensure DDR structures function as intended without adding extra time or cost to the project.

The webinar is for PCB designers, design engineers, system designers and hardware engineers of any experience level. To register, visit https://register.gotowebinar.com/#register/8852619336875902735

Hartley is an expert in printed circuit layout, signal integrity and noise control, with more than 40 years' experience at major high-reliability OEMs.

TPCA Publishes PCB Smart Manufacturing Roadmap

TAOYUAN CITY, TAIWAN – The Taiwan Printed Circuit Association initiated the research of a new roadmap for PCB smart manufacturing in Taiwan. With regard to the smart manufacturing implementation process and in consideration of the future challenges for the PCB industry, the TCPA, the Institute for Information Industry and the Taiwan

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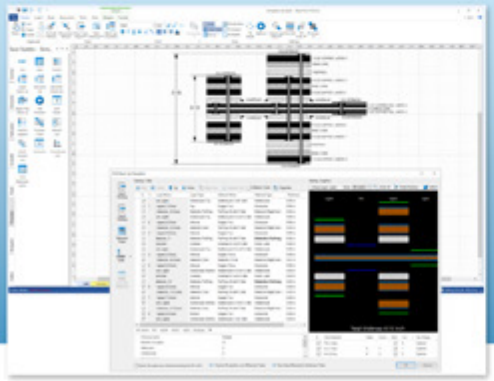
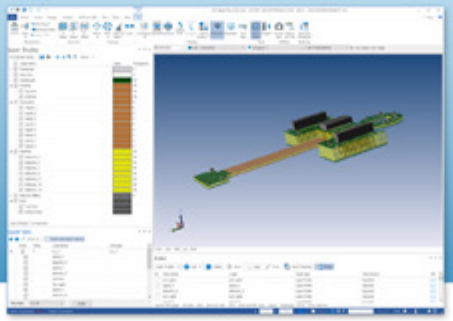
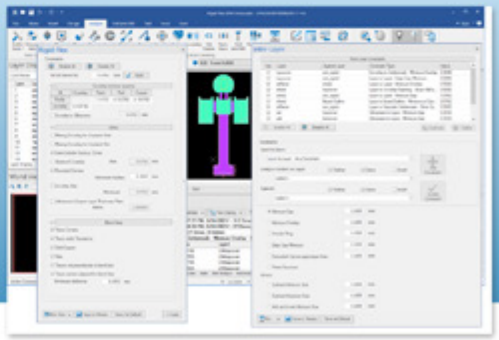


Use Stack Up Visualizer and Blueprint's Rigid-Flex Stackup template to easily manage and document rigid-flex stackups.



A rigid-flex design in 3D. Shown with layers spread to improve visualization of the layer stackup.



Use Rigid-Flex and Inter-layer DFM analysis to analyze flex and rigid-flex designs.

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Institute of Economic Research have updated the "Roadmap of Smart Manufacturing Development for Taiwan's PCB Industry."

This new roadmap plans the different processes for the development and application of smart manufacturing in the PCB industry. At the application levels, the framework covers smart equipment, smart production and smart operations. It is divided into linkage (data capture and integration), visualization (data presentation), transparency (data simulation and analysis), prediction (data prediction), and adaptation (decision support and guidance).

The plan aims to achieve visualization of production lines for the short term, smart production for the medium term, and smart operations for the long term.

The Printed Circuit Board Equipment Communication Interface established in collaboration with SEMI is the foundation for PCB smart manufacturing; it will help resolve various communication inconsistencies between PCB equipment and manufacture to accelerate the development of PCB smart manufacturing, TPCA says.

Intervala Acquires EPE, Expands US Manufacturing Operations

MOUNT PLEASANT, PA – Intervala in March acquired Manchester, NH-based electronics manufacturing services provider EPE Corp. for an undisclosed amount.

The acquisition enlarges Intervala's manufacturing capabilities, capacity and resources in the Northeast US and expands the company's global customer base. Intervala also has manufacturing operations in the Pittsburgh area and Hudson, NH. The addition of EPE expands Intervala's total operating space to 325,000 sq. ft.

EPE, which began doing business under the Intervala name immediately, was founded in 1957 and manufactures high-quality, complex printed circuit board assemblies and integrated electronic and electromechanical systems. The acquisition provides Intervala with additional manufacturing capacity in these capability areas and adds several top-tier customers in the defense industry and other high-reliability markets.

James D. (JD) Bell Jr., former president and CEO of EPE, as vice president and general manager, will be responsible for leadership and oversight of Intervala's operations in the Northeast region.

"Intervala's acquisition of EPE is an exciting and significant step in our strategy to grow and expand our presence and impact in the Northeast region," said Teresa Huber, president and CEO, Intervala. "We are delighted to welcome JD and his capable team who have built a highly successful business and longstanding customer relationships with excellent customer service and proven manufacturing expertise. We believe our two organizations are a great fit culturally and look forward to serving our new customers with a continued, unwavering commitment to customer excellence."

SVI Austria to Sell SVI Hungary in 2 Installments

PATHUMTANI, THAILAND – SVI Austria, a subsidiary of SVI Public Co., signed a share purchase agreement to divest 49% of its shareholding in SVI Hungary to ml&s Personalservice and ESCHA.

SVI Austria will continue to be a major shareholder in SVI Hungary, with 51% ownership for an interim period of two years. Thereafter, the purchasers will acquire the remaining 51%.

The value of the acquisition is less than 15% and the total size of all transactions in the past six months and does not exceed the 15% threshold limits as prescribed in the regulations.

The purchasers are expected to increase SVI Hungary's revenues with new business, as well as provide investments in new equipment.

ML&S is a subsidiary of Duotec, a German EMS firm with consolidated revenues of more than €230 million.

Rafi Electronics has moved into a new facility in Shanghai. The building has a production area of 7,800 m², of which 4,600 m² is a clean room area for SMT and THT assembly.

Rochester Electronics purchased **Austin American Technology's** AquaTherm 4.0.

Samsung Electronics has relocated two smartphone production lines of its business partners from Vietnam to its Gumi plant in South Korea.

Sanmina and **Reliance Strategic Business Ventures** have entered into an agreement to create a joint venture through an investment in Sanmina's existing Indian entity.

Yamaha Motor Europe Robotics will expand and renovate its offices in Kita-ku, Hamamatsu City, Japan.

Volex Acquires Majority Stake in inYantra Tech

BASINGSTOKE, UK – Volex has acquired a 51% stake in electronics design and manufacturing services firm inYantra Technologies for $13 million. The deal includes the $5 million purchase of 13.5 acres of industrial land.

The equity investment and property purchase will be in cash on completion from the company's existing debt facilities.

"The equity investment strengthens Volex's ability to provide flexibility and choice to its global customer base in the provision of its vertically integrated solutions by adding a new manufacturing region to its unique international operating footprint," Volex said in a statement.

The site expansion offers the ability to construct a new 100,000 sq. ft. medical and industrial technology cable assembly facility. Volex plans to expand in consumer electrical and electric vehicles.

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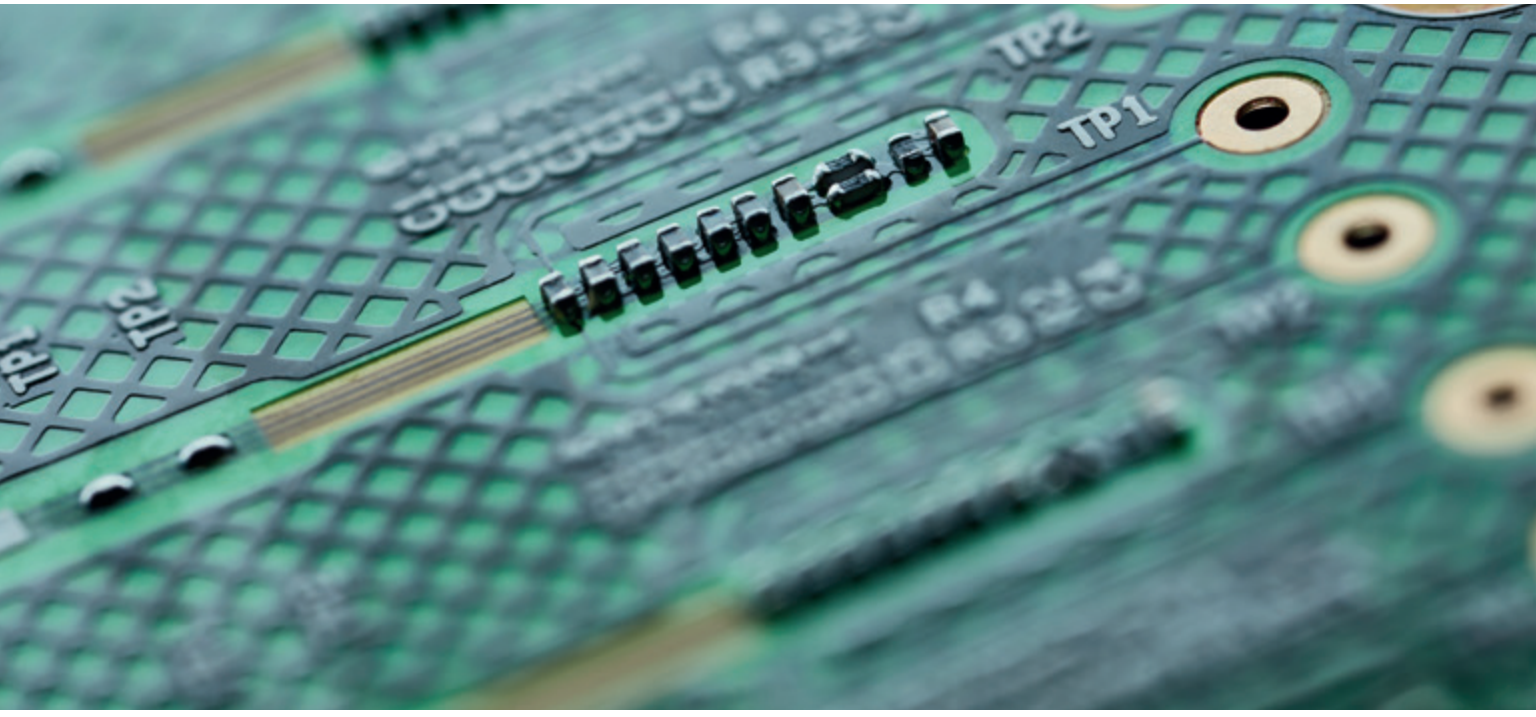

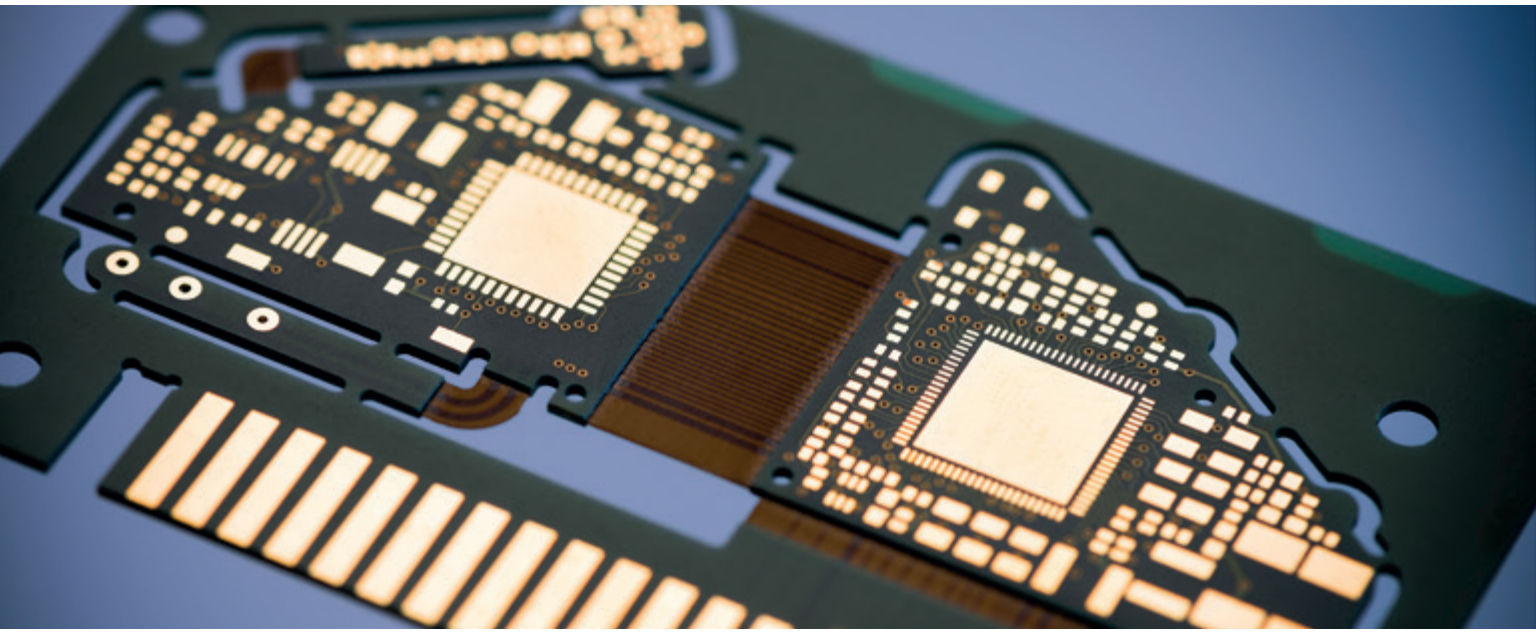

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TECHNOLOGIES

RIGID	
Standard:	2 – 28 Layers
Advanced:	30 – 38 Layers
Development (NPI only):	40+ Layers
HDI; BLIND/BURIED/STACKED VIA	
Lam Cycles:	Up to 8x
Micro BGA Pitch:	.2 Millimeters
FLEX / RIGID-FLEX	
Standard Flex:	1 – 6 Layers
Rigid Flex:	4 – 22 Layers
Rigid Flex HDI Lam Cycles:	Up to 2x

LEAD TIMES

RIGID	
Standard:	15 Days
2 – 10 Layers:	24 Hours
12 - 24 Layers:	48 Hours
HDI; BLIND/BURIED/STACKED VIA	
Via in Pad:	48 – 72 Hours
HDI :	3 – 15 Days*

** Depending upon # of Lam Cycles*

FLEX / RIGID-FLEX	
Flex 1 – 6 Layers:	5 – 15 Days
Rigid Flex 4 – 22 Layers:	7 – 15 Days
Rigid Flex HDI 2x Lam Cycles	20+ Days

QUANTITIES

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CONTINUOUS COMMUNICATION

Trends in the US electronics equipment market (shipments only)	% CHANGE NOV.	DEC.	JAN.	YTD%
Computers and electronics products	0.3	1.2	1.3	4.5
Computers	0.1	-2.1	0.4	-1.6
Storage devices	-2.7	1.9	5.7	9.0
Other peripheral equipment	-4.1	7.1	-5.9	-8.0
Nondefense communications equipment	1.0	-0.3	7.9	13.9
Defense communications equipment	-3.8	1.3	5.6	9.5
A/V equipment	14.1	-7.3	34.1	52.5
Components[1]	0.5	0.9	2.3	12.6
Nondefense search and navigation equipment	-0.5	0.3	1.3	1.6
Defense search and navigation equipment	0.1	-0.1	0.3	0.1
Medical, measurement and control	1.1	1.9	-1.0	1.0

[r]Revised. *Preliminary. [1]Includes semiconductors. Seasonally adjusted.
Source: U.S. Department of Commerce Census Bureau, Mar. 3, 2022

US MANUFACTURING INDICES

	OCT.	NOV.	DEC.	JAN.	FEB.
PMI	60.8	61.1	58.8	57.6	58.6
New orders	59.8	61.5	61.0	57.9	61.7
Production	59.3	61.5	59.4	57.8	58.5
Inventories	57.0	56.8	54.6	53.2	53.6
Customer inventories	31.7	25.1	31.7	33.0	31.8
Backlogs	63.6	61.9	62.8	56.4	65.0

Source: Institute for Supply Management, Mar. 1, 2022

KEY COMPONENTS

	SEP.	OCT.	NOV.	DEC.	JAN.
EMS (North America)[1]	-9.9%	-4.4%	2.5%	0.9%	-6%
Semiconductors[2]	27.6%	24.4%	24.5%	28.3%[r]	26.8%[p]
PCBs[3] (North America)	1.25	1.15	1.10	1.17	1.18
Computers/electronic products[4]	5.27	5.30	5.34	5.32[r]	5.27[p]

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

Hot Takes

- More than nine in 10 manufacturers have experienced **an increase in lead times** for parts and components since the start of the pandemic, with approximately half indicating an increase of one to three months. (IPC)
- **Worldwide hardcopy peripherals (HCP) shipments** declined 18% year-over-year to 22.3 million units in the fourth quarter. Shipment value was down 12.3% to $9.7 billion. (IDC)
- The 2021 **European EMS industry** grew 9% year-over-year to more than €44 billion (US$48.9 billion), an all-time high, beating the 2019 result by 1%. (in4ma)
- After surging 36% in 2021, **semiconductor industry capital spending** is forecast to jump 24% in 2022 to a new all-time high of $190.4 billion, up 86% from three years earlier in 2019. (IC Insights)
- Worldwide smartphone sales grew 6% in 2021. **Smartphone sales** rebounded in the first half of 2021, following a 12.5% decline in 2020. (Gartner)
- By 2025, 75% of companies will "break up" with **poor-fit customers,** as the cost of retaining them eclipses good-fit customer acquisition costs. (Gartner)
- Over half of chief human resources officers reported the **shortage of critical talent** as the number one trend impacting organizations, yet only 19% said their organization is prepared to bridge the gap. (Gartner)
- The global market for **EDA tools,** estimated at $9.1 billion in 2020, is projected to reach a revised size of $14.9 billion by 2026, growing at a CAGR of 8.7% over the analysis period. (Research and Markets)
- **Vietnam's smartphone shipments** grew 11.9% to 15.9 million units in 2021. (IDC)
- The **India traditional PC market,** inclusive of desktops, notebooks, and workstations, delivered a strong year, with shipment growth of 44.5% year-over-year in 2021. (IDC)

Taiwanese PCB Makers in China Set Revenue Mark

TAOYUAN CITY, TAIWAN – Taiwanese companies operating in China reported PCB revenues of NT$818 billion (US$28.8 billion) in 2021, up 17.5% year-over-year, according to the Taiwan Printed Circuit Association.

In New Taiwan dollars, this is the first double-digit growth since 2010 and set a new high for total output. Output grew 24.1% in US dollars due to currency fluctuations.

Substrate manufacturers expanded production capacity, while the penetration rate of 5G cellphones and EVs continues to rise, promoting the recovery of the overall economy. TPCA expects Taiwanese companies' combined domestic and foreign output will increase 6.5% this year to reach another record.

In 2021, Taiwanese companies' PCB production in mainland China accounted for approximately 63%, remaining nearly flat. Factors such as recent geopolitics, the global pandemic, China's power rationing and the IC shortage have prompted Taiwanese companies to employ different deployment strategies for domestic and overseas investment; regional production is emerging, says TPCA.

Except for rigid-flex boards, whose performance was constrained due to product applications, PCB demand was strong in 2021, especially for IC substrates, followed by multilayer boards, flex boards, HDI, and single-sided and double-sided boards. IC substrates benefit from demand for high-computing ICs, while high-speed memory drives the need for advanced processes.

Great demand was seen for ABF substrates and BT substrates throughout the year, with an annual growth rate of 33%. Multilayer boards benefitted from the work-from-home economy and strong demand for servers, with an annual growth rate of 21.6%. Flex boards for cellphones, laptops, tablets, and automobile electronics had an annual growth rate of 18%. In addition, HDI and single-sided and double-sided boards had growth rates of 13.5% and 8.1%, respectively.

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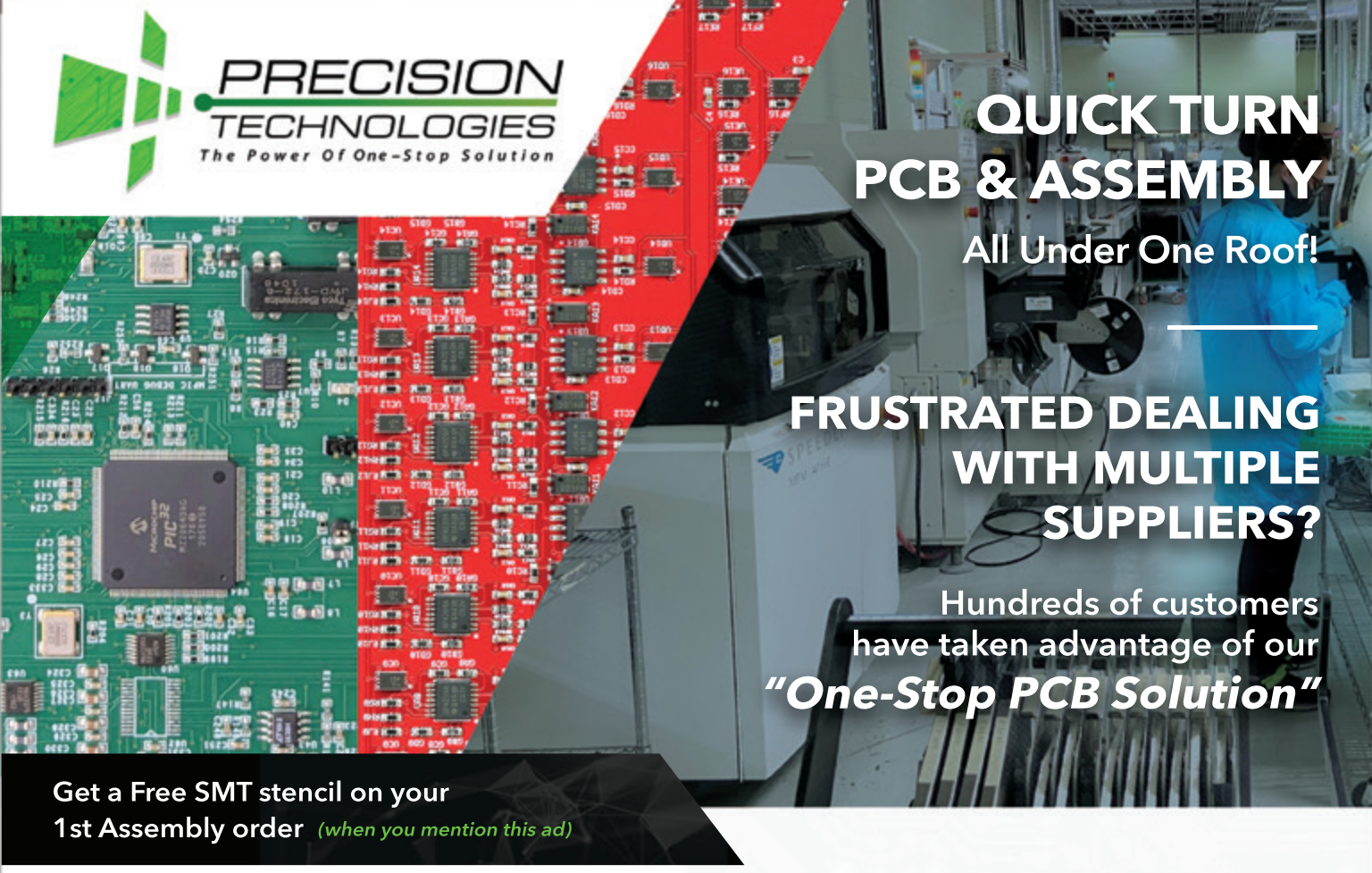

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Redefining the Meaning of Revolutionary Change

The pandemic taught us the importance of AI is not on the shop floor but in the ability of people to communicate.

FOR ROUGHLY HALF a decade, pundits have been waxing poetic about revolutionary changes about to take place in manufacturing – and in society at large – made available by advances in sensor technology that can be driven and manipulated by sophisticated software. Artificial intelligence (AI) and Factory (or Tech) 4.0 often best represent these revolutionary advances. Both have been touted to promise improving productivity, efficiency and speed, resulting in reduced costs and the need for fewer human employees where implemented.

I have never been a fan of any technology that replaces "human employees" but prefer technology that helps people achieve more. Based on the past couple years, that appears to be exactly what these revolutionary advances have actually achieved: using AI to enhance what people can achieve, rather than *replacing* them. How this has occurred, however, is different from originally imagined.

Many viewed AI and Factory 4.0 as enabling radically new products or game-changing process improvements throughout the manufacturing plant that would result in significant new products. In at least one way this came true, but in so many other ways, the game-changing has been subtler. Possibly the best example of this is in the area of communication.

Technologies that have the power to change how we communicate with each other individually or in groups have existed for almost a decade. Yet Skype, FaceTime, WebEx, Zoom, etc., were used sparingly. It took a pandemic to force a mass switch to cutting-edge communications technology. The promise of Factory 4.0 took a quantum leap forward both in performance and acceptance. However, it did so far from the factory floor.

Similar to Factory 4.0, AI has taken a significant step forward. Most were touting how the application of AI might enable large items such as automobiles to be produced in a fraction of the time with higher quality – or in our industry, maintaining process parameters over all processes on an ongoing, real-time basis, etc.

Indeed, AI has proved to be useful in a very different application. With the world stricken by a pandemic, the medical and pharmaceutical community harnessed AI and put it to work. Searching through vast databases in the cloud and thousands of global servers and computers, scientists developed a vaccine against Covid, a process that historically took years. Thanks to AI, data could be reviewed, sliced, diced and compared to real-time data from those stricken with Covid to develop and rapidly refine vaccinations that proved highly effective. In a short half-year, a monumental task resulting in a revolutionary solution was completed in a fraction of the time vaccinations and medications have been developed and approved in recorded history.

As communication technology has revolutionized and changed business communication, reducing the frequency of needed business travel and broadening locations where employees can work, has it really revolutionized the shop floor? Ditto as new vaccines were rapidly developed and immunization made available to millions of people, little or none of AI and Factory 4.0 has made it onto most manufacturing shop floors.

Maybe these two examples should make us redefine what a revolutionary change really is. Having a factory floor where every piece of equipment is connected, as Factory 4.0 pundits would have it, and software crunching data generated by scores of sophisticated sensors to run a lights-out factory floor, as those who prophesize AI would have it, should not be the goal.

Maybe the goal of investing in and implementing advanced technology should be measured in another way. The ability to increase the number of people who solve problems, implement new processes, or tweak something that is working well but could be better should be utilized 24/7 within the manufacturing environment, so the best solution can be derived more quickly. All the equipment need not be connected on one database, but all people required from all locations – supplier to operator to customer – to improve a product, process or outcome should use the technologies available to best communicate and contribute.

Developing new products or taking a bleeding-edge concept and making it reality should require all parties involved to share data, cloud-based or local, and we should invest in software and people who can slice and dice the extensive and complex data quickly to cut years, not weeks, off the product development process. Keeping people connected by advanced communication technologies and having the tools to assimilate, analyze and leverage immense and rapidly developing data has made a far greater contribution to economic and personal success than assuring all things are connected on the shop floor.

The global challenges for people are never-ending. Harnessing technology to effectively achieve the basics of communication and involvement is success enough, even if not the poster child of Factory 4.0. The need to dream big has never been more apparent. Focusing AI on those large tasks, rather than squandering it on simply moving inventory from A to B a little faster, should be the goal. And after all, it will be people who must manage the revolutionary advanced technology to achieve what is in the best interest of the challenges and the times. □

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Emotional Investment in PCB Suppliers Shouldn't Hamper Business

Buy PCBs with your brain, not your heart.

"Pray for me. I buy circuit boards."

THAT WAS A saying posted on the wall of a prospect I visited some 25 years ago. It's funny, of course, but it also speaks to an unchanging truth about PCB buying: It's often an emotional experience, especially when it comes to the bare board.

The PCB is the foundation of your products. It represents a good chunk – about 8 to 12% – of the cost of the bill of materials. While it is the first item needed to begin the assembly, it is usually the last item ordered. That alone can make buying boards stressful.

In my years selling boards and training companies how to buy PCBs, I've found it's not a lack of knowledge about circuit boards that prevents buyers from leveraging their annual spend most efficiently; it's misplaced loyalty or an aversion to risk.

In many cases, a triggering event that disrupts the status quo and creates a sense of urgency to solve a problem with the current PCB supplier initiates the buying process: quality, delivery delays, higher pricing, an acquisition and/or the imposition of tariffs. Many buyers in this situation will procrastinate on dealing with the problem, especially if it means changing vendors. Buyers want to protect the time and energy they've invested in their existing vendor base, no matter how bad the current situation.

Is your supply chain getting held up by vendors that are no longer up to the task?

I've seen board buyers stick with a PCB supply chain strategy even after openly admitting it isn't working. They've become emotionally invested in suppliers that used to provide good service. Often they develop a "we can't give up now" attitude and will continue to throw money at underperforming suppliers, giving them more orders, hoping they will improve.

In some cases, a particular buyer's ego will prevail over logic when it comes to the best interests of the company. Changing PCB manufacturers is perceived as an acknowledgment that a wrong decision was made.

I understand being loyal to vendors, and I'm not advocating to immediately dump a problem vendor. All PCB manufacturers have their strengths and weaknesses, and there was a reason you brought on a particular vendor in the first place. But they can become complacent, especially if they realize you are hesitant to move business. Your board orders must be constantly earned. Let *them* carry the burden of competing for your business. Are you leveraging your vendor, or is your vendor leveraging you?

I realize it's not always a board buyer's emotions that prevent them from developing the best PCB buying strategy. Management, as well as the production and quality departments, can have their own agendas when it comes to adding or changing vendors. Some EMS and OEM firms impose an overly cumbersome process on buyers before orders can be moved.

A good PCB buyer should constantly be reviewing present vendor pricing and actively quoting prospective new vendors. They should have the power to move business quickly if necessary. Companies that prevent buyers from doing this are only hurting themselves, and the truth is adding qualified suppliers is not as hard as many firms think it is.

When buying PCBs, I remind myself the customer always comes first, and in this case, *I* am the customer. This mindset makes it easier to make logical decisions that keep vendors working hard for my business. You should do the same. □

GREG PAPANDREW
has more than 25 years' experience selling PCBs directly for various fabricators and as founder of a leading distributor. He is cofounder of Better Board Buying (boardbuying.com); greg@directpcb.com.

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Handling Program Management Workload and Material Constraints

Strategic conversations are key to sustaining existing business.

THE CURRENT BUSINESS environment is creating two significant challenges for mid-tier electronics manufacturing services companies at a strategic planning level. The first is program management workload. Material exceptions have become the norm, and program teams have become highly reactive to respond to changing program variables. Second, material constraints are causing OEMs to keep projects at their current suppliers and push out launch plans on new products. Taken together, planning for account growth beyond what is automatically going in the pipeline based on spikes in existing demand may not be a great use of program management time.

While it is unlikely a significant number of projects will be awarded in the short term, a lot of dynamics in the background make strategically assessing larger accounts an important activity right now. These include:

- The great resignation. While the media may have overhyped it, labor shortages are a reality, and people are moving around as a result. Do you have multiple relationships within each customer's decision team? If you don't and your key contact leaves, you will be building a relationship with someone who is viewing your company only from the perspective of the current market.
- Customer chaos. The challenges within OEMs are as great as those within your company. In that environment, they may not be thinking strategically either. Can your company provide services to help address resource shortages within their teams they are unaware of?
- Inaccurate capabilities perception. In a reactionary environment, decisions are made on the fly. In a long-term outsourcing relationship, OEMs can lose sight of the company their EMS provider has become, or assume capabilities are limited to those used in the projects that EMS provider is involved in.
- Growing dissatisfaction. The current market is causing suppliers at all levels to give disappointing news on a regular basis. While experienced supply chain management teams understand what is happening, less experienced personnel may not. If the bulk of program team communication is delivering bad news, or if the ball is regularly getting dropped on issues the EMS provider should be able to control, dissatisfaction levels may be high.
- Cross-company teamwork is high. Many EMS provider and OEM teams are working together closely. The relationships forged offer visibility into opportunities at a higher level than is usually found when team members trust each other.

Given the current workload, the next challenge is determining how this type of analysis can fit into busy schedules. Strategically analyzing larger accounts relative to the dynamics mentioned doesn't need huge effort.

- Customer contacts. Make a list of the decision-makers you interact with at each key account. If fewer than three, develop a strategy to build a relationship with one to two additional contacts.
- Access what you know about the account. Are there opportunities for increasing the percentage of value-add in the account or growing into other divisions? What are this customer's pain points? Do they have resource constraints in engineering or production you could help with? Would fulfilling to their end market help free up their team? Is your team doing everything possible to help them with alternate component identification? Has your team failed at anything lately, when they should have performed better, such as in quality, product validation, communication, etc.? Do you have a solution for anything your customer has casually mentioned about new projects or resource constraints? Is the customer aware of your current capabilities? In short, make a list of issues you think would benefit from a focused conversation.
- Address dissatisfaction head on. If your team has fallen down on an aspect of the project they should have been able to control, do an internal review, document the corrective action and present it to the customer as quickly as possible. OEMs forgive issues created by the current market, but they aren't understanding when they feel internal processes are out of control. The result of this conversation may be improved customer satisfaction, or it may be the realization irreparable damage has been done. Either way, it puts you in a better position to assess next steps with this account in an environment of scarce resources.
- Educate, educate, educate. While it may seem difficult to have a strategic conversation in a reactionary environment, most customers are open to discussions that help solve their problems. An informational or educational approach centered on options for addressing specific pain points is gener-

continued on pg. 26

SUSAN MUCHA
is president of Powell-Mucha Consulting Inc. (powell-muchaconsulting.com), a consulting firm providing strategic planning, training and market positioning support to EMS companies, and author of *Find It. Book It. Grow It. A Robust Process for Account Acquisition in Electronics Manufacturing Services*; smucha@powell-muchaconsulting.com.

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Length Matching Routing for PCB Busses

Shortening and folding traces takes creativity and persistence, as long as the timing budget is met.

PRINTED CIRCUIT BOARDS are becoming more complex, with high-speed interfaces more common. Whether it is a PCIe, Ethernet, USB or memory of some kind, clock nets proliferate across the board. Those clocks have kindred spirits in nets that want to hit the receiver in conjunction with the ticking clock.

Crucial parameters of a group of traces include the target length or maximum. Less is more. Most other signals on the board will switch periodically. Meanwhile, the clock switches all the time. The clock uses the same voltage, but the constant stream of "10101010101…" creates more energy fields than a seemingly random sequence of ones and zeros. These constantly shifting reactive clock net fields are the reason we shield the clock, giving it space to do its thing.

"SHORTER CLOCKS HAVE COMPARATIVELY LOWER EMMISSIONS AND ARE LESS LOSSY."

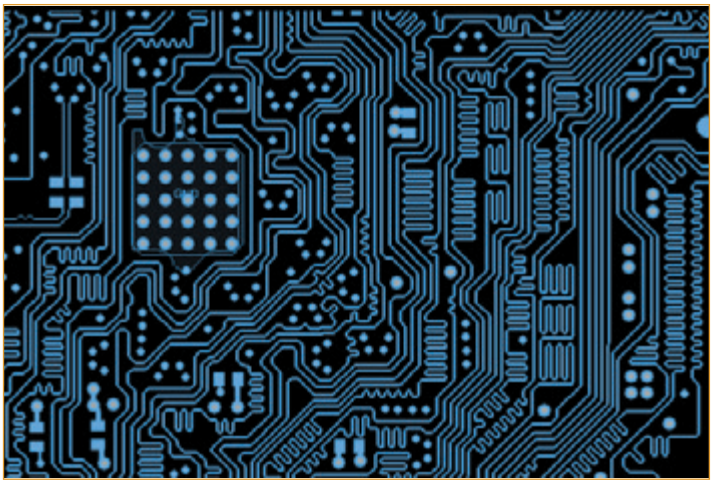


FIGURE 1. One of my favorite routing tasks: single-ended with 128 lanes, using two out of 12 layers. Due to placement, there was a lot of tuning, with two more layers full of differential pairs.

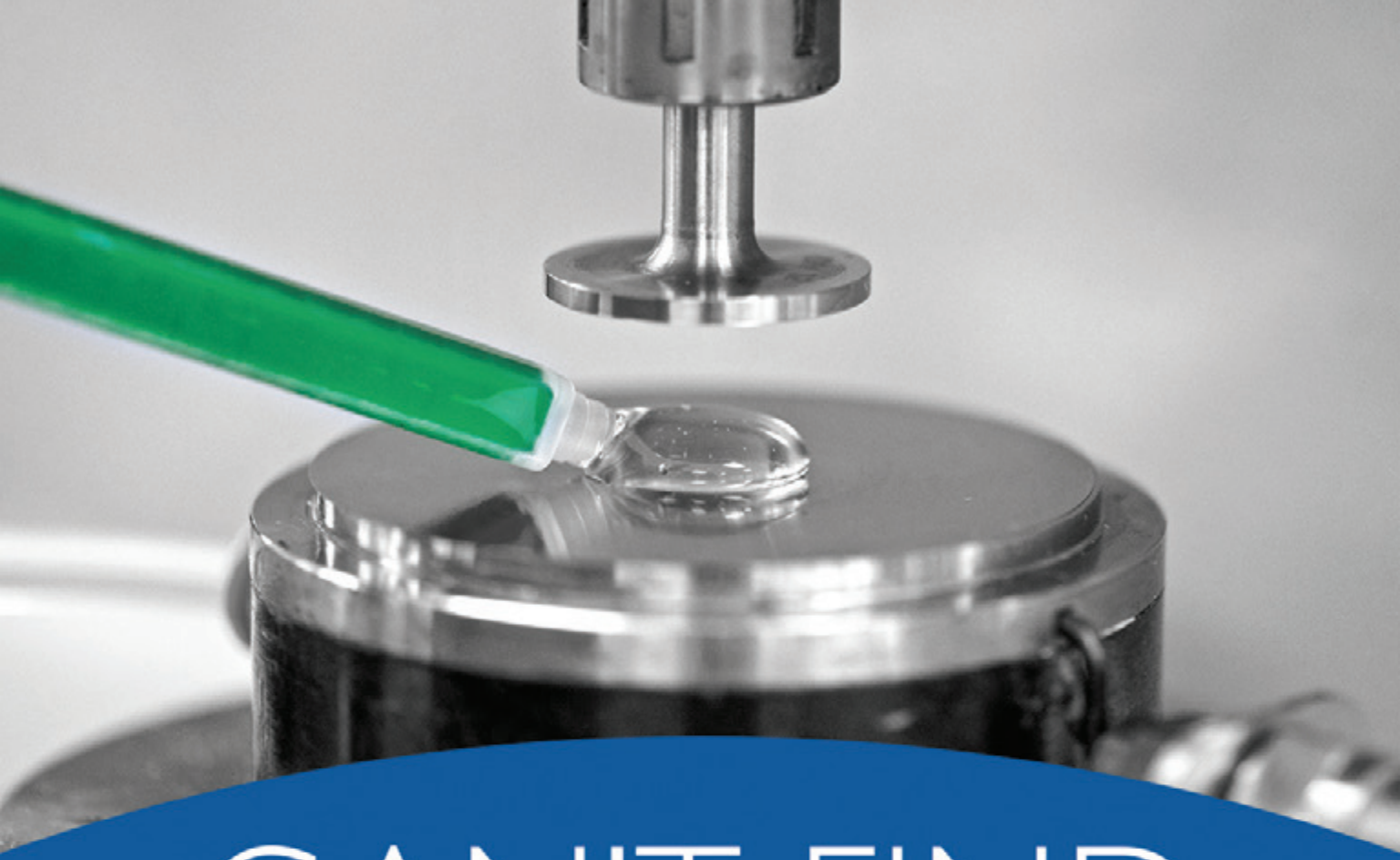
Shorter traces equal lower electromagnetic emissions. Shorter clocks have comparatively lower emissions and are less lossy. This gives rise to the use of available length matching tolerance to minimize the length of the clock, starting with finding the longest member of the group. Look at that net; locate any extra bends or places where it can be shortened.

Remember 45° angles are nice but not necessary, provided acute angles are avoided in the routing. Stretch that trace like a rubber band around the obstacles until it is as short as possible. Ideally, it falls to second place or farther down the list, sorted by length. Now, can you make the second longest one any shorter using the same process? Keep massaging the traces with a focus on shortening the longest ones. Once those longer traces are optimized, the ideal clock length can be calculated by subtracting the tolerance of the timing budget from the length of the longest connection.

For example, the longest trace in the group is 18.5mm, and the length-matching requirement is all traces are equal to the clock plus/minus 0.5mm. That indicates a clock length of 18mm. Why wouldn't we match all the lengths exactly? For one thing, that's beyond the spec. Second, it would compel the naturally shorter traces to grow to the full 18.5mm, rather than meandering to the point where it approaches the 18mm of the clock, minus the 0.5mm tolerance. The full range of the traces is 18.5 to 17.5mm, with the clock straddling the difference. Again, this ideal length for the clock is calculated by subtracting the tolerance (or most of it) from the longest trace once everything is optimized. The caveat is any editing of the clock or traces on the edge of the tolerance band is likely to upset the timing budget.

The upside is this uses the minimum amount of copper, every segment of which is a potential emission concern. This template could use the least amount of real estate as well, folding the traces to take up blank spaces in the overall maze. Once the traces meet the

JOHN BURKHERT JR. is a career PCB designer experienced in military, telecom, consumer hardware and, lately, the automotive industry. Originally, he was an RF specialist but is compelled to flip the bit now and then to fill the need for high-speed digital design. He enjoys playing bass and racing bikes when he's not writing about or performing PCB layout. His column is produced by Cadence Design Systems and runs monthly.



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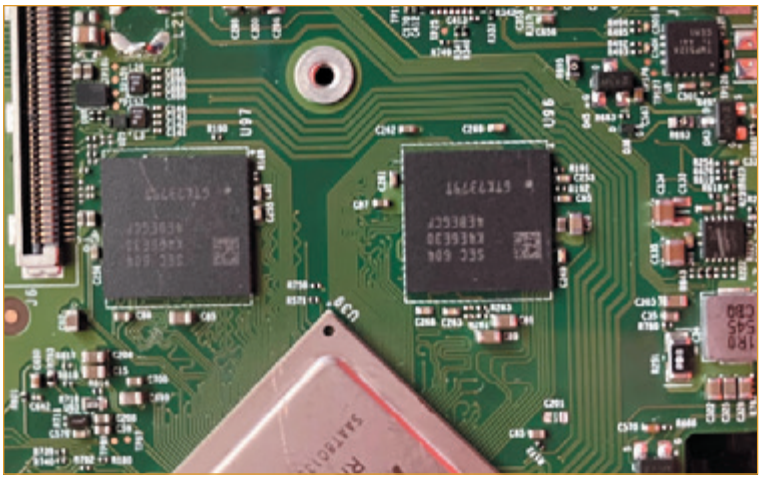

FIGURE 2. Some situations call for outer-layer routing, such as this DDR3 implementation, where the microcontroller is pinned out to mostly match the memory chip.

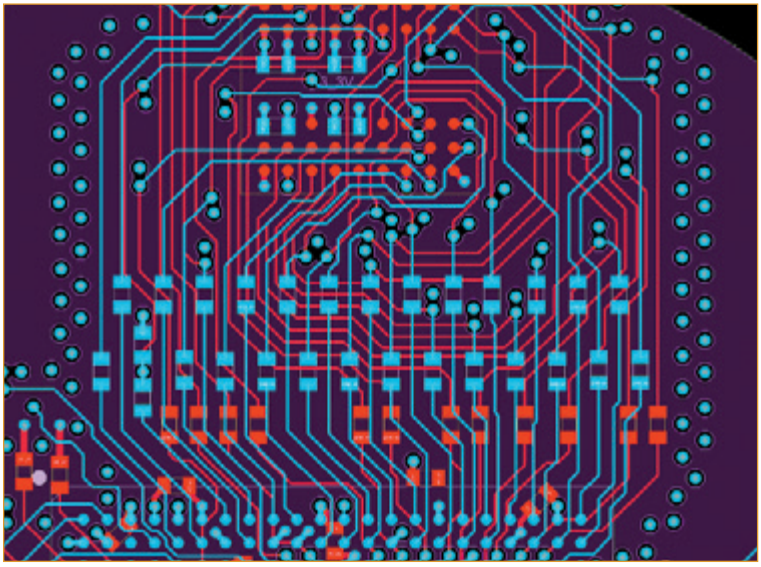

FIGURE 3. Another outer-layer approach driven by the series elements over a 4-layer PCB routing solution.

timing budget, it's not hard to add a wrinkle here and take one away from the same trace elsewhere. The wrinkle that goes away leaves room for the next trace to follow the new contours. It may seem tedious, but it's one of my favorite PCB design tasks, as it rewards creativity and persistence.

Match every trace in the group as close as possible. At times, the length tolerance is so small as to render these gains irrelevant. One example is EMMC, where the total number of wires is six, and only five of those are matched. They are well matched and one of those occasions in which I want every trace to be tightly constrained.

In that event, the gameplan is to make every trace the same length as the longest natural trace. Placement becomes critical, so the connections have a similar path. Signal integrity engineers generally prefer critical traces like these have all their tolerance available, meaning zero – or nearly zero – slack in the matching rules. Call it risk aversion, but sometimes you only get one chance to shine for the customer.

Time of flight rather than length of trace. Thus far, this discussion has been about the length of traces. In absolute terms, what we're really talking about is propagation delay. Delay is not measured in millimeters; it's measured in milliseconds. When the tolerances get unusually thin, we want to account for the physics in play, where traces on the outer layers allow data to flow faster than the traces on internal layers.

Calculating the time of flight involves taking the topology into account. We typically prefer the routing to go on innerlayers to reduce electromagnetic interference, even though the outer layers are faster in terms of propagation delay. This is slightly more complicated than measuring the trace lengths. Limiting the exposed traces to fanout areas is a simple way to manage the disparity. ❑

Focus on Business, continued from pg. 22

ally welcome. This is also a good way to increase customer knowledge of capabilities or resources. A quarterly business review or similar periodic meeting is one path. If the customer is local, a lunch-and-learn session may be beneficial. If the customer is accessible by travel and open to visitors, a visit with a technical resource may be an option. Ideally, information should open the door to ways your company can better serve the customer and any associated divisions.

When a program manager is prepared, discussions on ways to align solutions more closely with short- and long-term customer needs become easier. Analyzing accounts for opportunities is one way to counter the continuous bad news on the materials front. This type of analysis also helps identify potential vulnerabilities and either address the issue or build the assumption of eventual business loss into the forecast. In the current high-inventory business environment, it is always a good idea to understand which accounts have growth potential and which are quietly planning an exit. ❑

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The 'New Space' Revolution

The proliferation of satellites and the "orbital economy" have exciting implications for Earth – but not without challenges.

AN EXCITING MARKET is developing 300km above Earth. New Space promises to revolutionize the delivery of internet services and create new opportunities for Earth observation that could help us improve crop yields, anticipate natural disasters, and manage our impact on the environment. There are also opportunities for manufacturing in space, taking advantage of microgravity to produce high-purity optical fibers and materials such as graphene, semiconductors, and superconductors. The in-space, or orbital, economy is already being debated.

This commercial development of New Space, which defines low Earth orbits (LEO) in the 300km-2000km altitude range, has become possible through the ongoing democratization of rocket and satellite technology over the last few years. Until recently, space missions were mostly the preserve of government-backed organizations. Today, however, the responsibility for launching satellites, as well as taking people and supplies to the International Space Station, has become substantially outsourced to private enterprises.

The size of satellites themselves is also becoming smaller, while supporting increasingly sophisticated capabilities, allowing greater value at lower cost. Small satellites, or SmallSats, are generally considered to be less than 180kg and, in fact, have been in use since NASA's pre-Voyager missions of the early 1970s. The category is now more subdivided than ever and contains nanosatellites less than 10kg, picosatellites in the 0.1-1.0kg range, and femtosatellites of 10-100gm, although these limits are not rigidly defined. And, of course, there are CubeSats: the scalable proposal based on a standard 10 x 10 x 10cm basic building block. These are accessible to academic groups, including schools, as well as small commercial organizations.

Although many proposals for in-space manufacturing are currently theoretical and untried in practice, several large constellations have already been established to deliver internet access globally. These are expanding continually as new satellites are launched and connected.

Ultimately, services like OneWeb will comprise several hundred individual satellites, and we can expect even larger constellations containing tens of thousands of satellites in the future as services like SpaceX's Starlink are scaled up.

I'm excited about the opportunity here to deliver broadband services in locations not currently served by terrestrial connections. There is the potential to eradicate the digital divide, delivering high-quality services that offer speed and latency equivalent to conventional wired and 4G cellular connections.

But multiple challenges come with these opportunities: some technical and scientific, some political and ideological. Perhaps the most obvious technical challenges are associated with producing satellites in large quantities. Traditionally, this has been an extremely low-volume activity. Now, manufacturing must adjust to build significantly larger numbers of units – quickly and at low cost. On the other hand, performance, quality and reliability must remain as high as always. This will have an influence on the processes used for production and testing, as well as components and materials.

We can anticipate new generations of radiation-hardened components that will alleviate screening challenges and provide familiar logic, communication, and power ICs at lower cost per part. The makeup of printed circuit boards will also be affected. Polyimide substrate materials have historically dominated aerospace applications because of their ability to withstand thermal cycling. Electronic modules on board satellites experience high temperatures when exposed to direct sunlight, unattenuated by the earth's atmosphere, and extreme cold at all other times.

As commercial pressures take over setting the pace of development in satellite electronics, demands will grow to explore the potential for other materials and new formulas that offer different combinations of thermal properties, manufacturability, and performance at frequencies from about the 10GHz range to W-band frequencies as high as 110GHz. We are also seeing more flexibility in the design techniques approved for use in space applications, such as the use of microvias among efforts to minimize circuit board size and weight. Understanding the reliability issues associated with substrates, materials and processes is critical. There is no opportunity to repair failed equipment in space, so, once launched, the satellites and their payloads need to perform properly for the full design lifetime.

I have no doubt materials suppliers can rise to the challenges, and new materials well suited to the needs of commercial space services will emerge. Not everyone is excited at the prospects for New Space and the orbital economy, however. Some feel problems on Earth – such as hunger, war, and poor healthcare and sanitation, to name a few – must be addressed more

continued on pg. 30

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Bending the Flex in Rigid-Flex

Increasing distances between rigid areas helps prevent potential damage.

WHEN DESIGNING A rigid-flex that needs to bend 90° in the flex area, what is the minimum flex length (distance between rigid sections) one should allow?

That is a loaded question without knowing the overall thickness and width of the flex layers. For this column, I will assume only a couple of flex layers, and the flex width is 2" or less. Several issues come into play when determining the minimum distance between rigid areas on a rigid-flex. Some will affect the supplier's cost because of yield reductions, and others may affect the mechanical function.

Manufacturing issues. Fabricating a rigid-flex circuit means juggling a number of technical issues to get everything to work. First, the rigid material must be removable in the flexing areas. (The rigid material is applied in full sheets.) This can be done by pre-scoring the rigid-flex interface lines part way through and removing the adhesive in the flex areas used to bond the rigid material to the stack.

The other method is to pre-route the rigid sheets to completely remove the rigid material and adhesive in the flexing areas only. With the latter method, it is common to add a "pouch," a single layer of polyimide film used to protect the flex areas from the various plating chemicals during processing. The "pouch" is then typically removed after the final outline routing process.

In either of those fabrication methods, openings in the adhesive used to bond the rigid material to the stack must be lined up with the pre-score or pre-route windows in the rigid materials. A bit of misregistration during this process is typical. If you have a very short distance between rigid sections, this error can be a serious issue. Also, the registration process typically needs to be performed on both sides of the panel, so any potential alignment error could be in opposite directions, therefore doubling the damaging effect. And the smaller the distance between rigid areas, the more impact these misalignments have on final product performance.

Currently, most rigid-flex designs employ "cut-back" or "bikini" cover construction to reduce the amount of thermosetting adhesive film in the plated through-holes in the rigid areas. This requires the covers on the flexible layers be removed in all rigid areas. To do this, the cover materials are pre-punched to remove the materials that fall in rigid zones. If the flexing areas are very narrow, the small slivers of polyimide cover material that remain in the cover material sheet after punching are extremely flimsy and dimensionally unstable. Again, this has to happen on both sides of the board, so twice as much chance for error.

Adhesives used for bonding the rigid materials to the stack are usually no-flow prepregs. While the name is "no-flow," it does flow. The fabricator tries to predict the amount of flow expected along the edges of the rigid material and pulls back the adhesive, so during lamination the adhesive flows to – or slightly short of – the edge of the rigid board. Again, some misalignment is to be expected, and, as a result, the adhesive may flow slightly beyond the rigid edge in certain cases. The excess flow is usually minimal, but in cases with very short flex regions, it could affect board performance when bent. This condition will usually occur on both sides of the board.

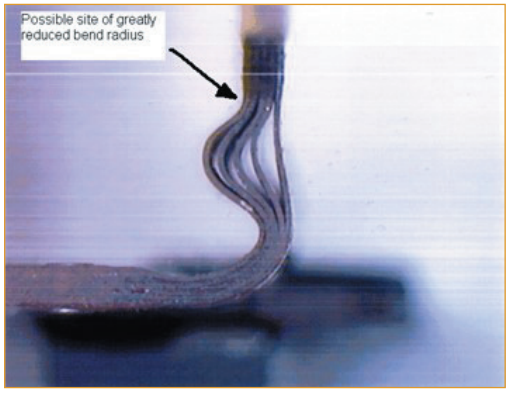

FIGURE 1. When the circuit is bent, unbonding flex layers result in the innermost layers buckling.

Mechanical performance issues. In rigid-flex designs that have very short flex areas, tension and compression forces associated with the bending operation are concentrated into a much smaller area. For this reason, if the distance between rigid sections is short, the thickness of the flexible layers needs to be kept as low as possible. Unbonded (loose leaf) construction is really not a viable option to increase flexibility in any application where the space between rigid sections falls below ~0.75". In addition to the aforementioned misalignment issues, unbonded construction presents the fabricator with additional layers of pre-punched adhesives between the flex layers that also need to be aligned to everything else. Unbonding flexible layers result in the buckling of the innermost layers in response to the compression forces exerted on those layers when the circuit is bent **(FIGURE 1)**. This

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buckling may result in a dangerously sharp bend radius at the rigid edges, which could cause cracks in the copper traces.

It is difficult to provide a hard, fast number to use as a guideline, since it is significantly impacted by the overall thickness/number of layers of the flex traversing between rigid sections and the overall width of the flex area. **TABLE 1** shows my *very* general recommendations, assuming all flex layers are bonded together, and flex length is 2" or less. Some flex suppliers can do smaller flex zones, and others need more room, but this gives you a place to start.

You can certainly improve on these numbers, but expect to see a cost bump from the supplier if they are pushed to improve on these guidelines *too* much. Also, these are *minimums!* If your design permits a larger distance between rigid sections, take advantage of that. Increasing the distance between rigid areas helps spread out potentially damaging forces when the circuit is bent.

TABLE 1. Flex Span Guidelines

No. Layers	Overall Flex Thickness	Min. Recommended Flex Span
1-2	<0.010"	>0.25"
3-4	<0.015"	>0.50"
4-6	<0.020"	>0.75"

You may also want to pass on adding strain relief if you are really shrinking the flex zones. Considering the average epoxy bead width is 0.030" to 0.060", and you would be adding along both rigid edges, a lot of space will be eaten by just the bead. □

Material Gains, continued from pg. 27

adequately before governments should subsidize economic development in space. Private enterprise will most likely do the lion's share of development.

Astronomers are also less than thrilled at the prospect of having satellite mega-constellations impair their studies. And then there is space junk. Even minute pieces of debris present a significant hazard to active satellites. Concerns about this issue began to arise after a few years of space exploration, resulting in the gloomy Kessler Syndrome that suggests an ongoing chain reaction of collisions could render Earth orbits practically unusable. To combat the problem, the United Nations has suggested satellite operators remove their satellites after 25 years in service. The space industry needs to work out a satisfactory way to accomplish this, which could be difficult given the many thousands of satellites expected to be launched over the next few years.

A plethora of private satellites are democratizing internet services, but space debris is a problem.

We can achieve great things by developing New Space, but, as we have discovered here on Earth, we need to be careful about the impact of our actions and apply equal ingenuity to minimize the damage, while making the most of the opportunities. □

ABSORPTION AND DISPERSION in PCB Interconnects

Reducing signal degradation requires dielectrics with lower Dk and LT, more metal and conductors without rough surfaces.

by YURIY SHLEPNEV, PH.D.

At a trade show a few years ago, our Simberian booth was next to a booth with a very loud demonstration transferring 112Gbps over a distance of about one meter through cables. I don't know how many terabytes of data they transferred during the show, but the demonstration equipment was noisy because of the industrial cooling equipment. I could feel the heat coming out of it. The devices were transferring data and not much else. How much energy is required to transmit data, and why is so much power dissipated into heat, I wondered.

PCB interconnects degrade digital signals. Signals may be reflected, coupled to other interconnects, or to power distribution structures or free space, but most important, conductors and dielectrics always absorb the signal energy and dissipate or turn it into heat. This article is about signal degradation due to the inevitable absorption and dispersion caused by dielectrics and conductors. How much energy does it take to transmit one bit of information, and where does this energy eventually go?

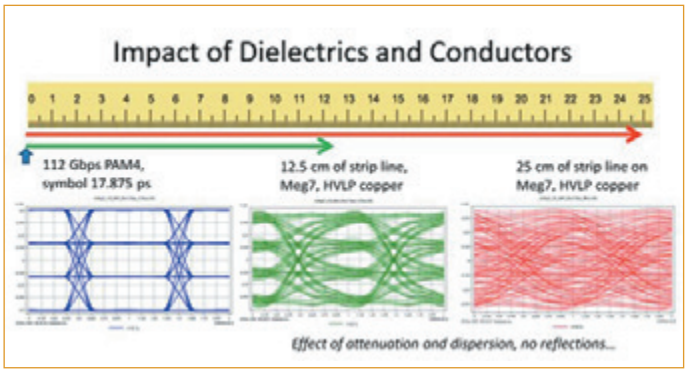

FIGURE 1. 112Gbps PAM4 signal degradation in a typical PCB interconnect due to absorption in dielectrics and conductors.

Energy Per Bit

Let's begin with the evaluation of energy absorbed (or dissipated) by copper interconnects. The power delivered to a 100Ω differential transmission line with 1V signal amplitude is 10mW. It doubles to 20mW if the transmitter source termination resistor is considered. Let's assume the link is ideally designed, as in **FIGURE 1,** with no reflections and coupling. (Such links can indeed be designed.) The remaining signal degradation factor is the absorption or dissipation, losses in conductors and dielectrics, and dispersion related to it.

So, if the link insertion loss due to absorption at the Nyquist frequency (half the bit rate for the NRZ signal) is -20dB, then we have 0.1mW at the receiver end (0.1V, 100Ω). Note receivers on some expensive components allow -30dB (0.032V, 10uW) and -40dB (0.01V, 1uW) loss at the Nyquist frequency. For our evaluation, however, it doesn't matter because the signal at the receiver end is also converted into heat at the termination resistor. *All* signal energy is converted into heat.

For a 50Gbps NRZ signal with 20ps unit interval, the energy converted into heat in a differential link with termination resistors is about 0.4pJ/bit (20mW x 20psec – product of power and bit time). This is practically an immutable bottom level. We cannot reduce the energy per bit in the copper interconnects under the assumptions provided above (1V, 100Ω). 20mW of power or 0.4pJ/bit for 50Gbps NRZ signal – is it small or not? It would take almost 929 hours to boil one cup of water. (Heat 200g of water from 20 to 100°C.) Admittedly, it does not look like much heat. However, this is just one link, and internet routers or switches may have more than 1,000 such links. That is enough to have a cup of tea in about an hour. This is still not impressive.

But this is not the end of the story. When equalization is included, the actual cost of a bit transfer on a PCB for 50Gbps is at least an order of magnitude larger. It is about 5pJ/bit (or 250mW) for 50Gbps NRZ.[1] With a thousand links, this is enough to prepare a cup of tea in five minutes, and the IOs on

chip dissipate about 90% of this energy.

Does this explain the industrial cooling equipment for 112Gbps links? I haven't seen the power consumption data for 112Gbps or the upcoming 224Gbps links. (Email me if you have it.) But, following the recent trends (doubling data rate increases required power by 30%), it should be about 6.5pJ/bit (325mW) for 112Gbps and 8.45pJ/bit (422mW) for 224Gbps.

The number of IOs does not increase at the same time. That may be the clue. Also, the prototype equipment may be much less efficient. On the bright side, some recent developments in this area promise to reduce the numbers to about 2pJ/bit or 100mW[2].

Why do we need so much power? To mitigate the signal degradation in interconnects between the driver and receiver. Transmitters and receivers are not two transistor devices in serial interconnects; they contain hundreds (maybe thousands) of transistors, and most of the energy is spent generating and restoring the signal. Can we reduce the power by design of interconnects? The answer is absolutely yes – by reducing the signal degradation in interconnects!

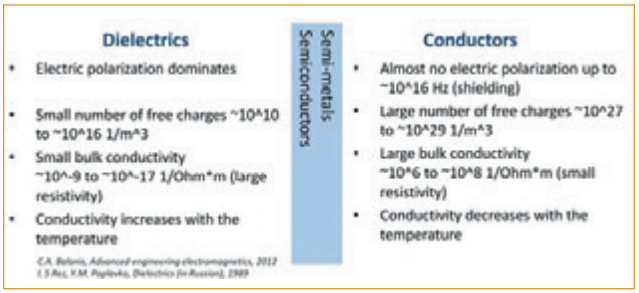

FIGURE 2. Properties of dielectrics and conductors.

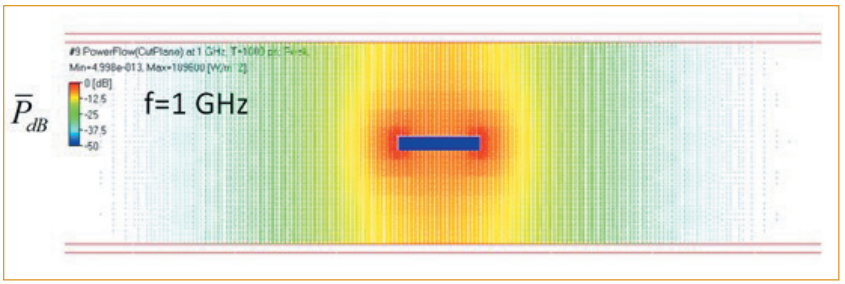

FIGURE 3. Power flow density in a typical PCB stripline interconnect (strip 1.2-mil thick, 7-mil wide, DK = 3.76, LT = 0.006 @ 1GHz, planes 0.77-mil thick, 17.2-mil apart).

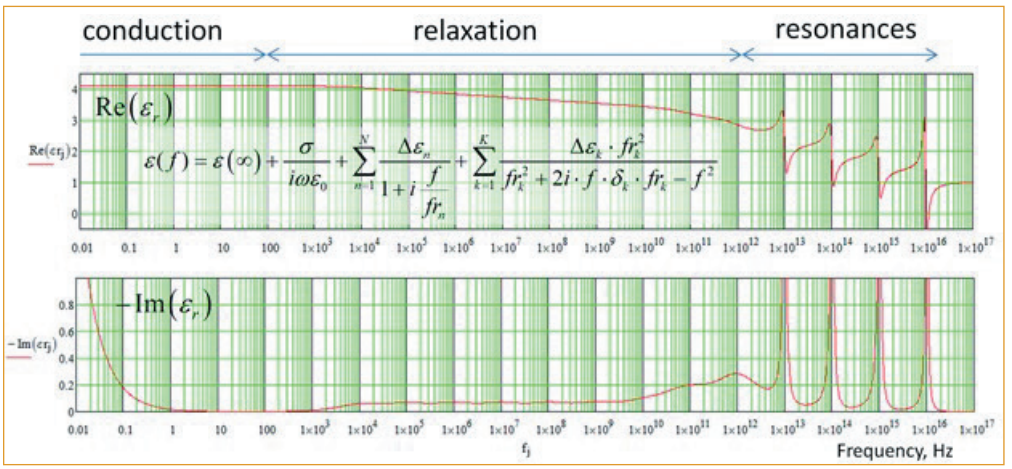

FIGURE 4. A universal dielectric model: the real part (top graph) and the negative imaginary part (bottom graph).

Energy Loss in Dielectrics

In general, more power and more expensive components are required for interconnects with larger losses or overall signal distortion, and lower power is needed for interconnects with smaller losses and distortions.

At DesignCon 2020[3], we discussed the major signal degradation factors and how to reduce them or design "transparent" or "clean" interconnects. The degradation factors can be broken into three categories: 1) absorption or dissipation by conductors and dielectrics and dispersion related to that; 2) reflections; and 3) coupling.

We called the first category "thermal losses" because the signal energy is literally heating the interconnect materials. Though, maybe "absorption" or "dissipation losses" are better terms.

When performing interconnect modeling, the following questions should be answered: What effects are important at a particular data rate? Does signal integrity software account for them? If all effects are included, will the model correlate with measurements?

Electrical properties of dielectric and conductive materials are outlined in **FIGURE 2.** Let's start with the energy absorbed (or dissipated) by dielectrics and the dispersion related to it. Why does the dielectric matter? Because the signal energy propagates along the PCB and packaging interconnects mostly in the dielectrics around the signal conductors. As Ralph Morrison points out, "Energy travels in the spaces, not in the traces."[4] The signal energy location can be illustrated with the peak power density flow (PDF), a vector product of electric and magnetic fields. For a typical PCB stripline interconnect **(FIGURE 3)**, the color scale is used to plot peak power flow density (PFD) in W/m^2 (shown in dB), computed with Simbeor THz.

The signal energy concentrates near the strip edges and between the strip and planes in the dielectric. The PDF

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is directed along the conductors into the picture. No power is actually moving in the direction of the signal within the conductors. All dielectrics absorb or dissipate the energy.[2] It is important to understand this.

In general, dielectric properties can be described with the permittivity that is a complex function of frequency – always for real materials! We call the real part of the permittivity the dielectric constant (Dk). The ratio of the negative imaginary part of permittivity to the real part is called loss tangent (LT) or dissipation factor (DF). It describes the power loss to heat and dispersion. A universal dielectric model may look like the one in **FIGURE 4.**

The model in Figure 4 is of a real material constructed from fitting measured data up to 50GHz and guessed above it. This shows the different mechanisms contributing to the losses in dielectrics (imaginary part of permittivity) and dispersion.

The conduction losses for the dielectric materials in the PCB and packaging dielectrics are negligibly small. They are responsible for the increase of the imaginary part below 100Hz. (This is not a typo.) There are very few free charges in the dielectrics, such as ionic carriers.

At frequencies up to 1THz, we are dealing with the relaxation of losses related to electronic polarization of atoms (RC circuit type – no oscillations). That is modeled as either multi-pole Debye or wideband Debye models[4]. That also means the Dk can only decrease with the frequency at these frequencies. We are dealing with composite solids here, mostly polymers. Lorentzian terms (oscillating RLC circuit type) are added for illustrative purposes to show the resonant properties of the solid PCB materials are important over 1THz, where Dk may go down because of the resonances.

A Causal Material Model

At "normal" frequencies up to 100GHz, dielectric polarization losses can be accurately simulated with the pole-continuous or wideband Debye models. Attenuation per meter from the dielectric in some PCB materials in a typical stripline is computed and shown in **FIGURE 5.** The attenuation shows an approximately linear dB/length growth with frequency.

The dielectric choice may have the most profound consequences on the link performance. For a 112Gbps PAM4 link, for example, the losses per meter at Nyquist frequency 28GHz (a quarter of a bit rate or half a baud rate) may range from 5.1dB/m for the ultra-low-loss dielectric to more than 100dB/m (practically a complete loss of signal) for the regular FR-4-type high-loss dielectrics. Note the ultra-low-loss dielectric with LT = 0.001 is still much more lossy than dielectrics used in cables. This is important to know when you decide to switch from PCBs to cables. There are many ways to reduce the losses on PCB interconnects.

A causal wideband Debye model is used here.[5] It can be defined with Dk and LT at one frequency point: 1GHz in this case. The model analytically defines the dielectric constant and loss tangent dispersion from 0 up to 100GHz. The model is causal and includes the dispersion (change in Dk with frequency) of the phase delay and characteristic impedance, as illustrated in **FIGURE 6.**

Phase delays are plotted on the left graph on the right axis in ns/m. Characteristic impedances are shown on the right plot in Ω. This simple numerical experiment demonstrates that not only are the frequency-dependent losses included in the model, but it also captures the dispersion of phase delay and characteristic impedance. The model is not causal if it does not include such dispersion.

It also demonstrates that dielectrics with high losses

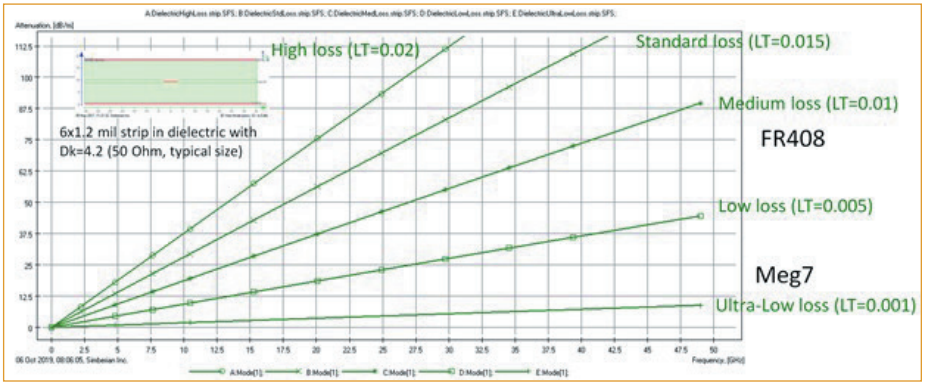


FIGURE 5. Attenuation per meter from different dielectric materials in a typical stripline.

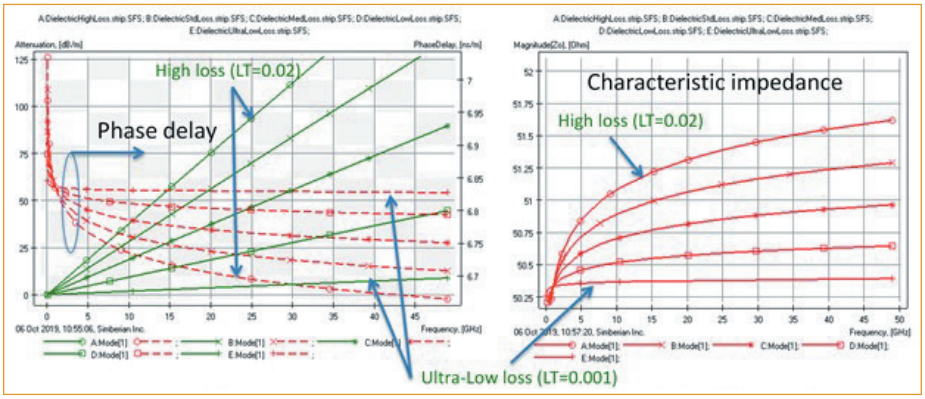


FIGURE 6. Dispersion of phase delay (left graph, red lines) and characteristic impedance (right graph) for dielectrics with different losses (green lines on left graph).

(typically FR-4) have much higher dispersion compared to the ultra-low-loss dielectrics that do not show much dispersion at the frequencies important for analysis of multi-gigabit interconnects. This is not only for the frequency-dependent losses; phase dispersion also causes signal degradation. Signal harmonics are attenuated more at high frequencies and travel with different velocities as well.

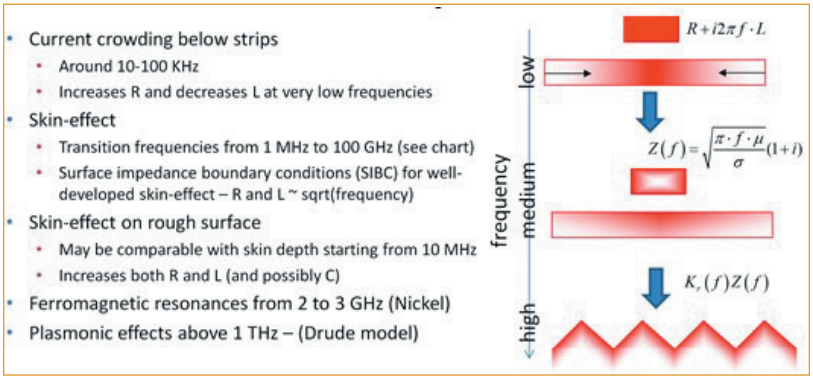


FIGURE 7. Conductor absorption and dispersion effects.

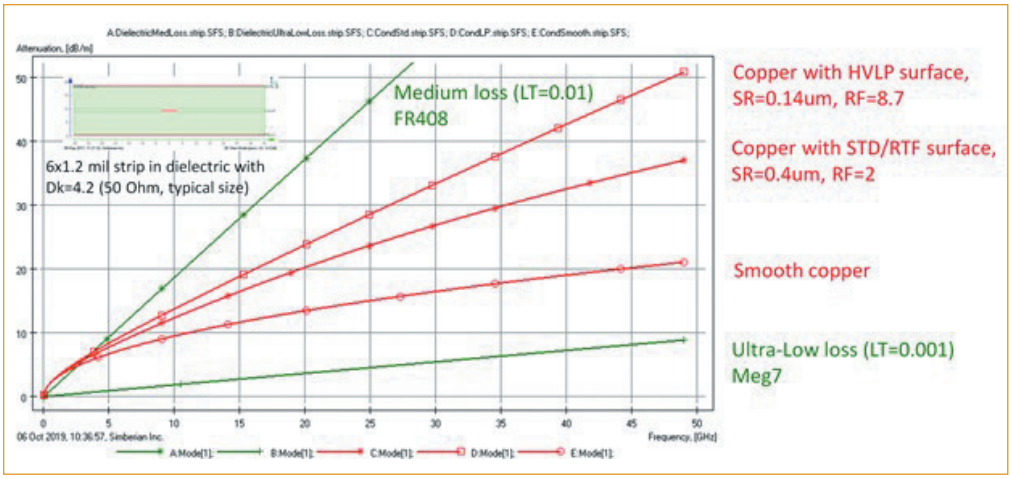


FIGURE 8. Attenuation from typical conductor roughness (red plots) in typical stripline compared with the attenuation due to dielectric losses (green curves).

Losses in Conductors

Conductor losses were extensively covered in a tutorial[5] and in "How Interconnects Work: Modeling Conductor Loss and Dispersion."[6] Conductor absorption and dispersion effects are summarized and illustrated in **FIGURE 7.**

Although the currents in the conductors flow along the signal propagation direction (and back), the power flow vectors within the conductor always point almost exactly perpendicular to the conductor surface. Conductors literally absorb, or "suck," the energy of the signal and convert it into heat. This is because it is the tangential component of the H field that propagates into the conductor that accounts for the power loss.

Though conductors are an indispensable part of PCB interconnects – with no viable alternatives so far – additional unavoidable losses and dispersion are related to them. In the case of dielectrics, the absorption can be illustrated with the losses per meter, as shown in **FIGURE 8.**

Dielectric losses for the medium and ultra-low losses are plotted on the same graph as green curves for the compari-

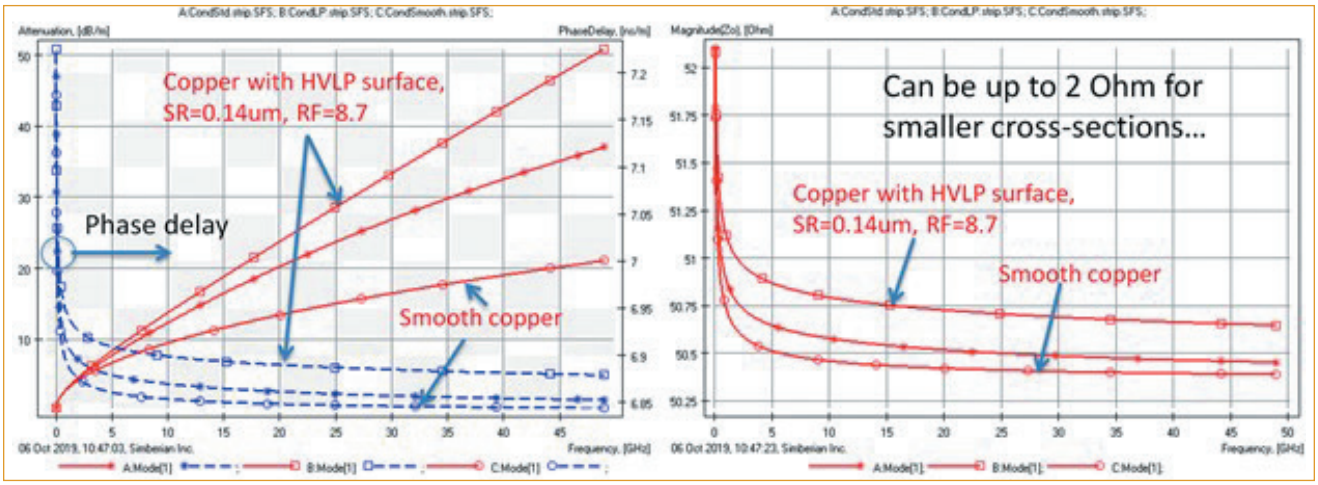


FIGURE 9. Dispersion of phase delay (blue curves on left graph) and characteristic impedance (right graph) for different copper roughness (red curves on left graph).

son. Three red curves are computed for a strip width of 6 mils (about 0.15mm), with smooth copper (no roughness), STD or reverse-treated copper (middle curve) and HVLP copper roughness. Parameters for the roughness models are taken from validation projects and were identified with the measurements.

Even with smooth copper, the conductor losses may exceed the dielectric losses for the ultra-low-loss dielectric (valid for a particular cross-section), meaning the minimum possible losses on a PCB are limited mostly by the copper and copper roughness. To have the losses on the PCB closer to cables over a similar bandwidth, larger, smooth traces must be used, reducing current density and overall losses. As a result of the causality requirements, the conductor losses cause dispersion of the phase delay and characteristic impedance, as illustrated in **FIGURE 9.**

Again, if a model does not have the dependency of phase delay and impedance from the roughness model parameters, such a model is not causal and, thus, may not be accurate enough. Always do numerical experiments to verify the dispersion associated with the frequency-dependent loss to see what is in the model. See more on the inductive effect of roughness.[6,7]

What about the predictability of the absorption or dissipation losses and dispersion? In other words, how do we build models that correlate with the measurements? It depends on availability of the frequency-continuous ultra-broadband models for dielectric and conductor roughness.

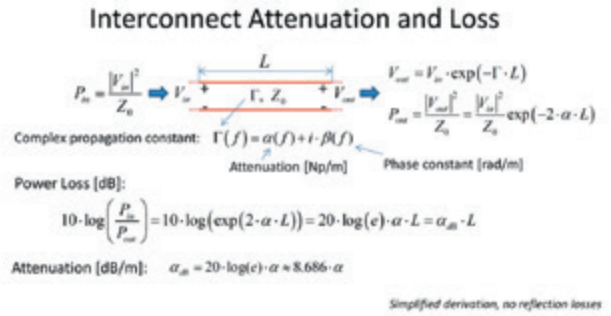
Dielectric data from laminate manufacturers can be used to construct such models with sufficient accuracy for preliminary analysis or lower data rates. (They can be defined with a numerical experiment).[5] Dielectric models for higher data rates and better accuracy must be extracted from measurements. Parameters for conductor roughness models are usually not available and always must be extracted from measurements. Identification with GMS-parameters[8] or SPP light[9] techniques with a separation of dielectric and conductor losses can be used to build dielectric and conductor roughness models.

Reducing Power Consumption

Here is how to reduce the signal degradation due to the absorption or dissipation losses:

- Use dielectrics with lower Dk and LT.
- Use more metal to reduce current density. (Wider interconnect traces absorb less energy.) (This is subject to single-mode propagation limit.)
- Use conductors without roughness or "engineered" rough surfaces without additional losses.

Generated signal energy is always turned into heat in conductors, dielectrics or termination resistors, no matter what we do with the interconnect losses. However, interconnects with lower losses reduce the energy required for signal conditioning and restoration. This is valid under one important condition: very low reflections and no coupling. □



REFERENCES

1. D.R. Stauffer, "Progress and Challenges for Next Generation 400G Electrical Links," OIF CEI-56G Project Activity, www.ethernetalliance.org/wp-content/uploads/2014/06/Panel-2-Speaker-2_D.-Stauffer.pdf, June 12, 2014.
2. B. Razavi, "Low-Power Techniques for Wireline Systems," ESSCIRC 2021 – IEEE 47th European Solid State Circuits Conference (ESSCIRC), https://ieeexplore.ieee.org/document/9567882/, September 2021.
3. Y. Shlepnev and V. Heyfitch, "Design Insights from Electromagnetic Analysis and Measurements of PCB and Packaging Interconnects Operating at 6- to 112-Gbps and Beyond," DesignCon, January 2020.
4. R. Morrison, "Limiting Radiation from Logic Circuit Boards, PCD&F/CIRCUITS ASSEMBLY, October 2018.
5. C. Nwachukwu, Y. Shlepnev and S. McMorrow, "A Material World: Modeling Dielectrics and Conductors for Interconnects Operating at 10-50Gbps," DesignCon, 2016.
6. Y. Shlepnev, "How Interconnects Work: Modeling Conductor Loss and Dispersion," Simberian App. Note #2016_01, 2016.
7. "How Interconnects Work: Rough Conductor Currents and Internal Inductance," Simberian video #2017_09.
8. Y. Shlepnev, "Broadband Material Model Identification with GMS-Parameters," IEEE Conference on Electrical Performance of Electronic Packaging and Systems, 2015.
9. Y. Shlepnev, Y. Choi, C. Cheng and Y. Damgaci, "Drawbacks and Possible Improvements of Short Pulse Propagation Technique," IEEE Conference on Electrical Performance of Electronic Packaging and Systems, 2016.

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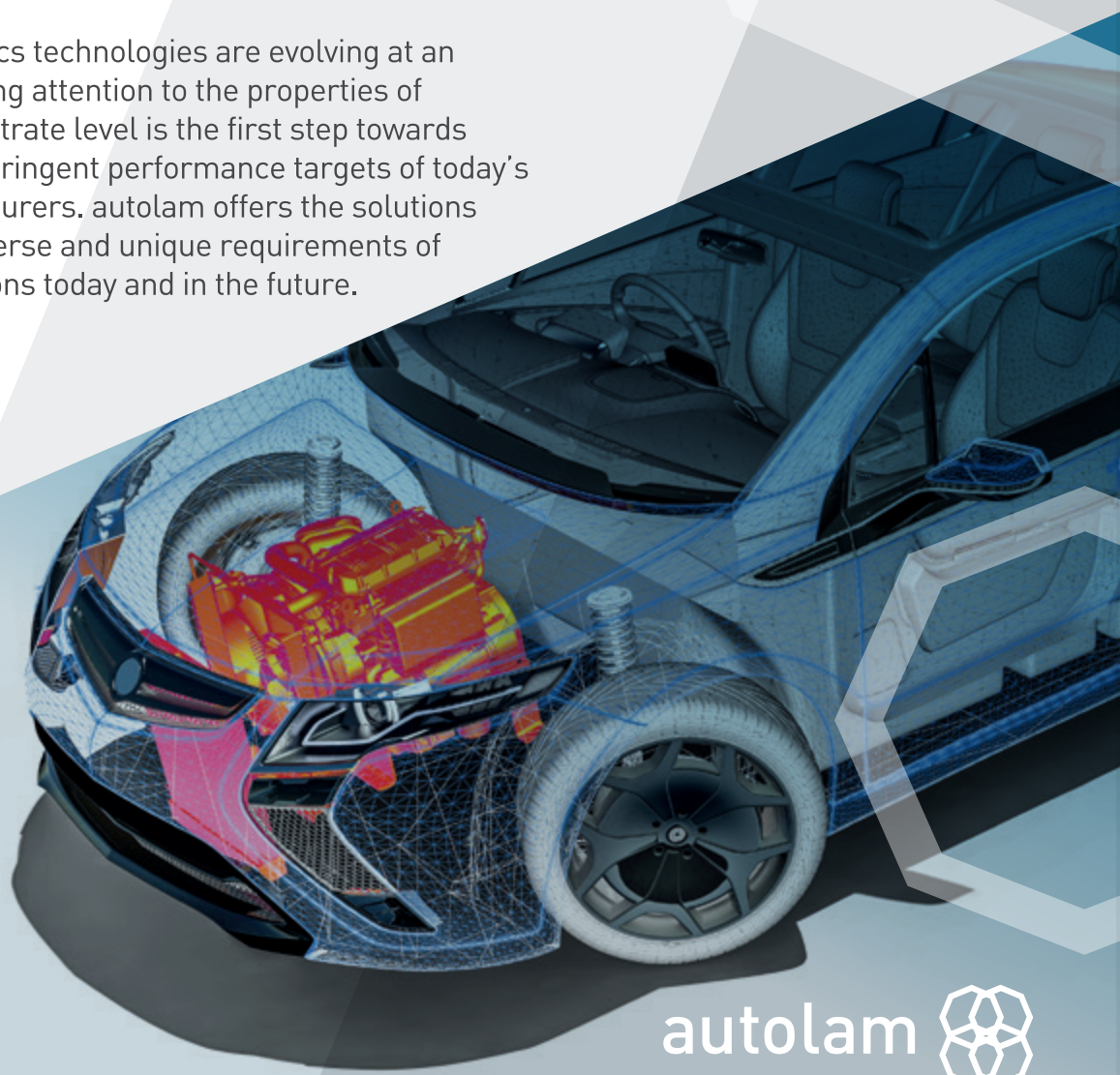

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As ROHS IS 'RECAST,' Questions Arise Over Eco Standards' Efficacy

With recycling efforts well below international targets, will manufacturers be forced to adapt again? **by CHELSEY DRYSDALE**

Environmental issues have been front and center in electronics for decades. Most engineers today remember when the Restriction of the Use of Hazardous Substances in Electronics (RoHS) first went into effect in July 2006.

Michael Kirschner is president of Design Chain Associates, where he helps manufacturers understand and ensure their products comply with health and environmental regulatory, customer and market requirements. He has broad expertise in areas including semiconductor quality and reliability, software design and development, hardware design, development, and manufacturing, as well as manufacturing processes and supplier/supply base management.

This background enables him to help manufacturers assess and improve supply chain risk, readiness and performance, and achieve compliance with REACH, RoHS, Circular Economy, EcoDesign, CEAP, WEEE and other related health, environmental and social regulations.

In March he spoke with PCEA chief content officer Chelsey Drysdale on the open comment period for RoHS 3, the circular economy, and why environmental and sustainability standards have yet to achieve their goals.

Chelsey Drysdale: On your LinkedIn page, you have called attention to the ongoing public consultation period of RoHS, which I believe ends later this month. What is your general sense of the European Commission's environmental goals with this latest comment period?

MK: I think they're going to bring RoHS into alignment with the Circular Economy Action Plan (CEAP). Just what they will do should have been defined in their circular electronics initiative, which was supposed to be published a few months ago but still hasn't been released. To answer the question, I would have to look back at the call for evidence, which is really what you're asking about here. This is the call for the open stakeholder consultation that's ongoing right now. It's almost over.

CD: I saw March 14 as the deadline.

MK: Yes, March 14, so there's not much time. The Commission was required by the RoHS directive – in Article 24, paragraph 2, specifically – to carry out a general review of the directive and present a report to the European Parliament and Council, accompanied by, if appropriate, a legislative proposal. That was supposed to be in place by July 22 last year. They did get the general review that a couple consultancies produced, but they did not get a legislative proposal. That's what they're working on now. They've [received] a lot of input and complaints over the last decade about 2011/65/EU. I think they've identified in this call for evidence things they want to deal with, or they believe they have to deal with, like scope problems, which they've addressed. There's still a few outstanding. The FAQ has not been revised since 2012. At this point, it's hopelessly out of date and really needs expansion in certain areas. One of the big ones is what is meant by "large scale," particularly when it's addressing large-scale installations.

Michael Kirschner, product environmental compliance/safety expert, circular economy thought leader, and president, Design Chain Associates.

There's two big issues: the exemption renewal process and the substance review process. The exemption renewal process is probably the one that's affected most manufacturers. They initially had 18 months from the time the exemption renewal application date ended to come up with an answer about whether they were going to renew the exemption. That year and a half turned into years, so that was very optimistic. The first time around, they got 80-some exemption renewal applications. Now we're seeing the same problem because we've got exemptions that will expire in 2024, and we don't have clear indication of whether those exemptions will be renewed.

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The substance review process is challenging as well because we don't have a clear understanding of what the methodology is for selection and evaluation. We have a draft process from the Commission but not a natural process, and here we are 20 years into RoHS. It's unclear to a lot of people why it differs from the REACH process – the evaluation part of REACH – which is pretty well-described.

We also have the EcoDesign directive, which all of a sudden in 2019 banned an entire class of halogenated flame retardants from enclosures for monitors, displays and televisions. There's multiple different paths for substances to get restricted and affect an electronic product.

We do have the RoHS process itself, as I mentioned, which is fairly unclear, but it looks like it's going to result in a couple substances getting restricted at some point in the near future, perhaps under RoHS 3 or whatever replaces it. One is going to affect the printed circuit board industry, and that's tetrabromobisphenol-A. If that gets restricted, it may or may not have an impact. I don't see it having a significant impact because TBBPA is not present in printed circuit boards, since it's reacted to form the epoxy for board material, as well as mold compounds for ICs and other devices where it's still used. It's just any remaining level of the substance can't exceed the limit, probably 1000ppm. Those are what I see as the big issues, but they also say enforcement has been challenging, particularly with e-commerce, and then there are certain unclear and outdated provisions on spare parts or scope and insufficient provisions to support the circular economy, that is, for secondary resources.

Environmental standards haven't lived up to their potential for changing cradle-to-grave behavior.

CD: As a follow-up, the EC says this version initiative will simplify and increase the efficiency of the current rules and improve their enforcement. How so?

MK: That's in one of the options they are suggesting as a possible outcome of this process. They say they're going to clarify and improve the exemption criteria and process; clarify and approve the substance restriction trigger criteria process, both of which I mentioned before; ensure coherence with other legislation, primarily REACH and EcoDesign; and improve implementation and enforcement. How they will improve enforcement is unclear to me. By making it a regulation, I think that could make it easier because then all the member states have essentially the same regulation to look after. They may have their own enforcement regulations, but at least they'll have the same regulation. I think to improve that, they would have to specify more common enforcement criteria and mechanisms across all the member states because right now they're very different. In some places you can go to jail; in other places you might just get fined for the same offense.

CD: What is the proposed timeline for the latest rev?

MK: According to the Commission work program for 2022, the revision of RoHS is planned for the last quarter of 2022, so sometime later this year. Whether they hit that, we don't know.

CD: In a post on LinkedIn, you suggested the EC could eliminate RoHS. What are the chances of that? If it does, what are the implications for the market?

MK: That's a good question. I didn't really suggest that; the Commission did. They gave us several possible options, one of which is repealing the RoHS directive and incorporating its provisions into the REACH regulation. I don't think that's going to happen because they're two completely different regulatory mechanisms. REACH has a much broader horizontal scope. It regulates chemicals across almost all applications of them. RoHS is in the electronics vertical. RoHS restricts the homogeneous level and REACH, at least the disclosure aspect of it in the authorization part, a candidate for list of Substances of Very High Concern, that's at the article level, which is a different level than homogeneous materials. The restriction mechanism under REACH is all over the map. It's very dependent upon what the chemical is and how it's used, where it's used, what the markets are, etc.

The other possible way they could repeal the RoHS directive is by addressing product requirements related to the environmentally sound recovery and disposal of electrical and electronic waste under sustainable products legislation — that is, in the context of the Sustainable Products Initiative (SPI) or revising the EcoDesign directive. This is an option where they tie together RoHS with the EcoDesign directive framework, which is directive 2009/125/EC. Implementing measures are written for that for specific product verticals that historically have only focused on energy, but the EcoDesign framework directive allowed them much greater latitude about

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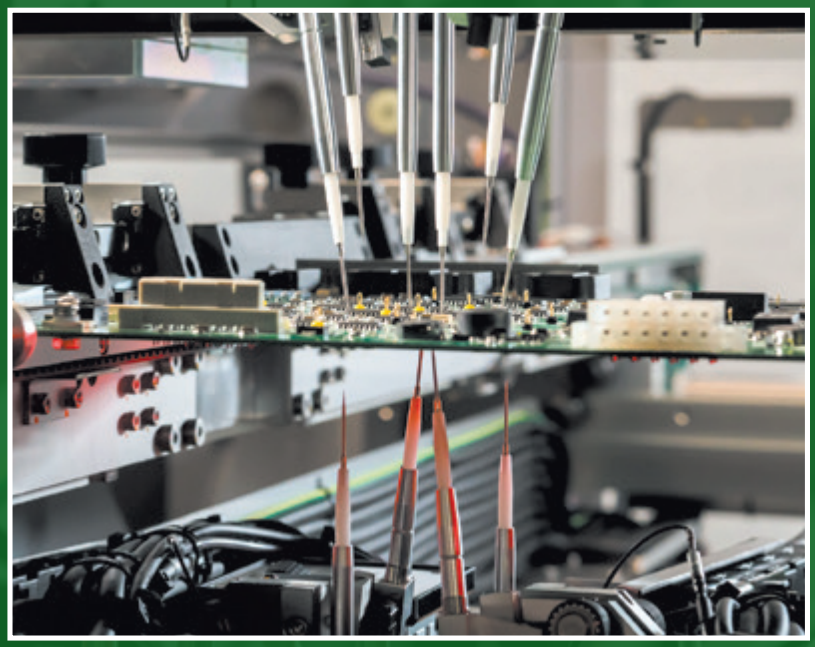

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what they could address. In the past few years for monitors, displays and TVs, they added a ban on halogenated flame retardants. They're also addressing other aspects of materials and circular product design that are beyond energy and energy use to other implementing measures to the extent that they're actually specifying functionality for products in some cases. For instance, your dishwasher has to have a specific mode with a specific name. It's wild. They also say they could just maintain the RoHS directive as it stands and update the FAQ. I think that would be a big mistake because the RoHS directive has problems. They say they could simplify and clarify RoHS by introducing and revising legislative and other measures. That is fairly likely. They say they could transform the RoHS directive into a regulation. That also is fairly likely. I think those two are really the most likely approaches moving forward, as opposed to just wiping it out altogether or incorporating it into REACH or leaving it as is.

WEEE's impact has been underwhelming, with about 40% of e-waste properly recycled.

CD: One criticism of RoHS is that analysis testing is burdensome and lacks consistent measures, thus the potential for discrepancies. Would this issue be resolved if the Substance of Very High Concern requirement replaced RoHS, as some have suggested?

MK: Testing is not a requirement of RoHS and disclosure, particularly at the article level, which is the SVHC requirement for those not based in the EU and subject to the authorization aspect of REACH, whereas SVHC disclosure ultimately can become a ban, unless you're authorized to use the SVHC. That's just not the same as restriction at the homogeneous material levels, which is the RoHS approach. So that's just not going to happen. I'm not sure who is thinking the SVHC requirement is going to replace RoHS; that's unlikely.

Testing is just not something I think is the right approach. The preferable method is to simply get the compliance documentation from your supplier. I think testing is an appropriate mechanism to keep suppliers honest or to verify their information as needed, but it's not really a solid or reliable primary mechanism to ensure compliance against the RoHS requirements, which are at the homogeneous material level. Testing is simply not going to get you the data you need, including the detailed exemption information at that level at a cost that's reasonable. It's going to cost like $200 to test a part to see if it has RoHS substances in it. If you have a complex product with thousands of unique parts, that can really exceed a rational amount of money. And even if it doesn't – even if you've only got a handful of parts – it's unclear to me what testing gets you. You have to do it for every lot of every component that's used in your product over time, unless your supplier can guarantee lot-to-lot consistency, and you believe them. If they have process control and you believe them, then why are you testing? I think people need to reread IEC 63000, which is the harmonized standard defined by industry and approved by the European Commission to replace the testing requirement, which is defined by the new legislative framework 768/2008/EC, because testing again is just not rational. This is why manufacturers post their material composition or post sometimes useful, very often useless, certificates of compliance on the website, so you don't have to test. Sometimes you may have to inquire a bit more deeply to make sure what the suppliers are giving you is actually meaningful. But that's another story.

CD: What can we expect in terms of a ripple effect to other markets if/when this version of RoHS is ratified?

MK: It may influence them; it may not. Countries that are trying to become EU member states will generally be more likely to implement whatever changes the Commission makes, but others like China are under no such obligation, and they're going to aggressively remind you of their sovereignty when you ask them about it, so they don't have any obligation to do so.

Mike Buetow: If I remember right, you started your career as an electronics designer.

MK: I've done that sort of work. I've had a long and sordid career [laughs], mostly in semiconductor quality and reliability and component engineering, but I've also done electronic design work, software development, all kinds of things.

MB: I'm guessing the term circular economy wasn't part of your vocabulary back then.

MK: No, definitely not.

MB: If I understand it right, the idea of the circular economy is to extend the useful life of products and materials by creating these loops of the materials and products circulating in the economy. If this is the end of RoHS, which doesn't seem likely based on the conversation here, what does that mean for the circular economy? And in your opinion, does the alphabet soup of other regulations, in particular WEEE, enhance that loop as well as they could?

MK: Great question. I don't think WEEE has been as successful as the Commission has expected it to be. That's why I

think we're seeing them talk about the circular economy. They have been less than successful in achieving their goals for the percentage of e-waste that's properly recycled. It's somewhere around 40%, according to their own data, and I think they expected it to be above 60% by now, but even that's not enough. Fundamentally, we're still using the classical linear product lifecycle process to both design products and manufacture them. And really, manufacturers haven't made any changes to process or design to products to make them more recyclable or more reusable. They've just paid the amount of money the recyclers and member states are asking and said, "OK, it's your problem now." That's what the circular economy is about: "OK, we've had enough of this. We've got the European Green Deal."

The Circular Electronics Initiative [ed.: part of CEAP] was supposed to give us a sense of how this is all going to change because we do have all these alphabet soup regulations that affect electronics in kind of a piecemeal and different manner. I think they're going to try to tie this all together to be more sensible and coherent, rather than have RoHS, REACH, EcoDesign, the POPS [ed: Persistent Organic Pollutant] regulation, packaging, batteries – all these different regulations impacting one aspect or another of the electronic product and the design of that product. I don't know how they plan to make it more coherent, but I certainly expect to see changes to a regulation that simply bans substances like RoHS to make it more circular. For instance, if you simply ban a substance and don't control what the replacement is, you may or may not get a more environmentally preferable substance. Manufacturers are generally going to do what's least expensive and most expedient, and if that least-expensive, most-expedient alternative is not the most environmentally preferable, or if it's about the same as what is being banned, then there you go. That's happened a couple times with RoHS specifically. It turns out, for instance, the tin-lead solder LCA versus the tin-silver-copper LCA are about the same. You're not getting a significant improvement in environmental performance going to tin-silver-copper, when you look at the whole lifecycle of tin, silver and copper in that application versus tin and lead according to the US EPA's analysis of LCA. Another example, and these are regrettable substitutions because you're going to have to replace them again, we replaced decabromodiphenyl ether when it was banned by RoHS with decabromodiphenyl ethane, both extremely similar molecules. The ethane is a drop-in replacement in most ABS plastics for the ether, and it's pretty similar in terms of not only functionality but toxicity. Canada is actually banning that now. They've gotten ahead of the EU. Unless [governments] control these other substances and really drive the industry toward improving the environmental performance, they are simply putting the industry on a treadmill, and we won't be able to get off. Hopefully they'll be a little smarter about how they implement the RoHS recast and circular economy requirements. It will be very challenging for them and for the industry.

CD: If readers have a takeaway from all of this, what should it be?

"MANUFACTURERS ARE **NOT IMMOVABLE OBJECTS,** BUT I THINK THE **EUROPEAN COMMISSION** IS AN UNSTOPPABLE FORCE, **SO THEY WILL WIN,** BUT THEY NEED **COHERENT FEEDBACK** FROM INDUSTRY."

MK: Hold on tight. [laughs] If you have a chance to submit a comment to the European Commission, do it by March 14. If you don't have a chance to do that, keep your eye on this process because I expect there will be another stakeholder consultation once we see the draft of the RoHS recast: RoHS 3. In addition, in general, manufacturers have to take this stuff seriously. Manufacturers are not immovable objects, but I think the European Commission is an unstoppable force, so they will win, but they need coherent feedback from industry. They really do because they're not experts in what we do, and I think they have a lot more power leeway than they probably should have in this space because there is no good counterbalance to them. When they have hundreds and hundreds of toxicologists working at the European Chemicals Agency, as well as the Joint Research Center, they have an enormous amount of expertise within the Commission to study this stuff and deal with it, and industry doesn't. The electronics industry, regardless of how huge it is, has those resources really limited to the largest of large manufacturers, and we don't have a separate think tank that focuses on this area to help guide the industry and help it move toward where it needs to go, as well as provide coherent feedback to the Commission and other governments. We've produced products for a very, very long time without thinking about the environment, and we're campaigning for it now. That's where we have to focus, and governments are forcing us down that path whether we like it or not. Manufacturers have to start spending the money, spending the resources, and really taking it seriously. Otherwise, it's just going to be more and more pain. ▫

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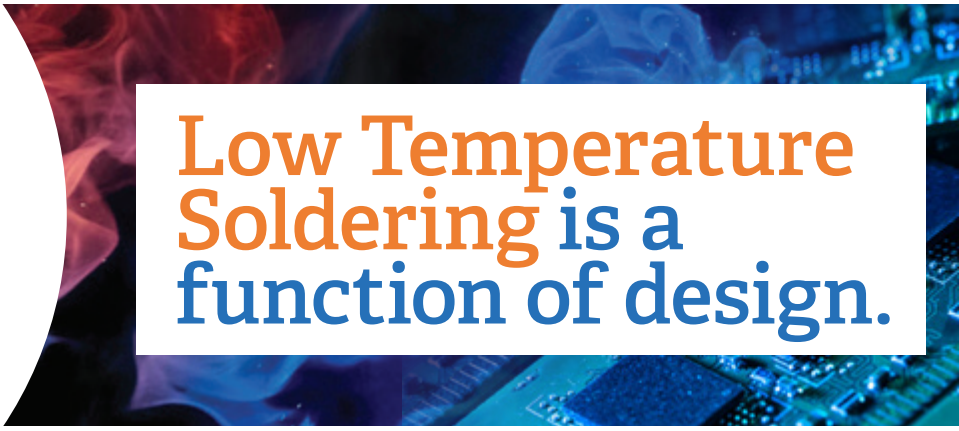

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Mack in MEXICO: 'It Just Makes a Lot of Sense to Be Here'

Mexico's appeal over other geographies is driving big expansions at EMS companies looking to supply the North American market. by **MIKE BUETOW**

Mack Technologies is one of the largest family-owned EMS companies in North America and probably the world. Headquartered in Westford, MA, it also has facilities in Melbourne, FL, and Juarez, Mexico. It recently completed a move to a factory in Juarez that is more than double the previous plant's footprint.

We talked in January with president Will Kendall and vice president of operations, Mexico Oscar Gonzalez about the expansion, doing business in Mexico, and why when it comes to retaining employees, the stomach rules the body.

Mike Buetow: Oscar, I have visited the plant in Westford a couple times, but I haven't been to Juarez or Melbourne. I understand you've made a substantial capacity expansion to the Juarez plant. Could you give us an overview of what the expansion includes, and what spurred the changes?

Oscar Gonzalez: This move stemmed from our growth. We used to be in an 82,000 sq. ft. facility, and over the past few years we've been growing by leaps and bounds, and we ran out of space. As we continue serving existing and new customers, we made the strategic decision to move into a 2x building: a 164,000 sq. ft. facility. We're occupying 50% of it, with the strategic vision to fill it out in the next few years.

The new building is state-of-the-art. It's located north of the city, very close to the US-Mexico border – about a five-minute drive, which is very convenient. The new building was built with the latest technology in construction materials: tighter, most energy conservation, and so on.

We have seven SMT lines and are installing an eighth by the end of February. The idea would be to double it, from eight to 16 in the next two years.

Will Kendall: I would add that a lot of the growth we're seeing is driven by existing customers, and we've been trying to support them and support their growth. We needed additional capacity to be a good supplier and be able to grow with our customers, in addition to the fact that we are getting a lot of interest from potential customers who have seen our operation who are very interested in how Mack operates in Mexico, and we've seen a very large increase in demand that until we had the new building in place would have been challenging to accept new business.

One thing I'll point out about the building is we've learned a lot from stories from other companies that are relocating operations and buildings. One of the key criteria was the location be convenient for our workforce. We didn't want to move the building and find out the workforce didn't move with it. We selected a location that, with our geomapping analysis, is a significantly shorter commute for over 80% of our staff. We've been in production in the new building for just over a month, and the latest information I have is turnover due to the new location being inconvenient for employees was less than 2% of the workforce, which we're very happy about.

MB: What are turnover rates in Mexico compared to, say, your US sites?

WK: They're higher. The market is higher. It's very nuanced. The truth is that, in Mexico, the way the labor laws historically had been, there used to be a trial period of 90 days before employees would be permanent, so historically the turnover rates are really high. But it's almost all driven by new hires who were within that window. I believe the law is different now, so there is no trial period, but that same phenomenon still is in effect where, if there's high turnover, it's almost always within the first three months of someone's tenure.

The tenure for employees beyond those first three months is generally a lot lower, but on average turnover in Juarez, or Mexico in general, is higher than turnover in the United States.

OG: Another important factor on turnover is the corporate culture. You see variations of that from industry to company. Mack Technologies has been working on a Lean culture where everyone's voice is heard. I think our culture tends to [result in]

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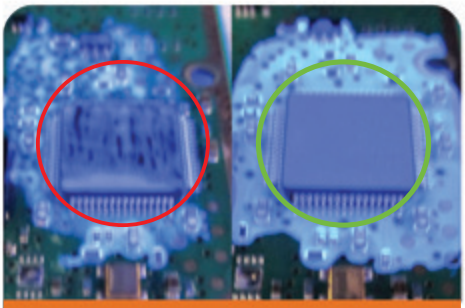

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The new 164,000 sq. ft. plant doubled Mack's footprint in Juarez.

a better turnover than most. People want to work for Mack. As Will was saying, with this move, it's another proof that we retain the majority of our employees and workforce, so we have same workforce, same employees, same equipment all in the new site.

MB: That answers one of the questions I had, which was is this an addition to the old site? It sounds like you packed up and moved.

WK: It's probably about 25 minutes closer to the US border, deeper into the city than where we were, which was generally more on the outskirts.

OG: We were close to the airport in the south part of the city. There are several industrial parks in that area, so we moved to an industrial park, Los Fuentes, which is very conveniently located five minutes from El Paso, Texas. The Texas-Juarez border is, from a logistics perspective – for import/export, as well as the ability to bring in customers – really convenient, and we're in a well-established industrial park in a brand-new building.

MB: How big is Juarez now compared to Melbourne and Westford?

OG: Juarez is a 164,000 sq. ft. facility, 900 employees.

WK: Melbourne's 145,000 sq. ft., and Westford is 108,000 sq. ft. Employee-wise and square footage-wise it's our biggest, but not by a huge margin, especially considering we're now working to grow the actual production.

MB: If I remember right, your equipment set was pretty similar from site to site. Is that still true?

WK: That's still true. Our strategy has always been to have similar equipment platforms that we use. I don't remember when you were here last, but the equipment set platforms have changed dramatically.

MB: You were a Universal shop then.

WK: For SMT we still are Universal, except everything now is Fuzion, and we've standardized on a handful of other platforms as well. We use Yamaha for 3-D AOI, Omron for 3-D x-ray. We've standardized not only on the equipment side but also on the IT side. We run one ERP system across the company. We run one MES system across the company. We've tried to standardize on the best equipment sets and IT solutions, so we've got as much efficiency as we can for continuous improvement.

The equipment sets in Juarez are all the same equipment set packages as Massachusetts. There are some small differences but not many, so for specific customer reasons.

MB: Besides SMT, you're doing box-build, and what else? Are you doing plastic molding in Juarez?

WK: We do not do plastic molding in Mexico. All the injection molding operations are our sister division, Mack Molding. At Mack Tech we only do the electronics assembly, box-build and full product fulfillment pieces of business.

MB: Can you handle RF in Juarez?

WK: Oh yeah.

MB: What types of programs are best suited for Juarez?

WK: Right now, the best types of programs for Mack Juarez

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are generally in industrial or ruggedized end-market products where the volumes are what we would consider medium-volume, although volume is a relative term, but generally higher volume than the US, but we're generally not building millions of products.

What usually works well in Mexico is where there is more labor content. If something is automated through machinery, that can generally be built anywhere cost-effectively. When products start to have additional labor requirements, that's when Juarez becomes a very attractive option for the customer, which usually fits our model as well. With all the changes with tariffs and the Section 301 tariffs in China and the logistics bottlenecks throughout the world, Mexico has, in our view, become one of the most attractive places in the world for building products destined for North America.

MB: We talked about staffing in terms of not losing people, but are the basics of finding qualified labor, are the obstacles similar in Mexico as they are in the US?

OG: There are different dynamics for sure. In Juarez we have 10 colleges and universities where we draw highly skilled engineers from, and planners and business management personnel. The structure of the city government and the universities really supply all that indirect labor. No issues.

Juarez City as a whole has seen growth over the past few years, and there's a lot of migration from Central Mexico to Juarez, so we are very lucky to still have that pool of direct labor. With the growth in the number of companies, we also have seen growth in population. We are at a point where we meet our hiring requirements quite easily, the challenges being turnover, absenteeism, just like anywhere else. I think the city structure and universities and population dynamics have afforded any manufacturer in Juarez no problem in attracting high-caliber talent, as long as you have the right culture and the right operation.

WK: I would say in general there are obviously labor shortages all over the country in almost every industry right now, and manufacturing is certainly not immune to that. From our perspective it has been easier to attract greater numbers of workforce in Juarez. I don't want to speculate why that is, but on a relative basis we're finding it easier to scale up with a larger workforce in Juarez than we are seeing in the US right now.

MB: Going back to when I first started in the industry, which was 1991, the word from EMS companies in Mexico was often large numbers of employees might pick up and leave for another factory down the road because they offered better meals in the cafeteria and things like that. Is there a lot of poaching that still goes on between EMS companies, because there's quite a few of them in that area.

OG: It happens. I think the best companies are retaining talent; it's no secret. We do taste contests on the cafeteria providers. They have to be well-established. In Mexico we have a saying: "tummy full, happy heart." You provide great food and great service … there's statistics on this. There's been studies on what are the three key elements of what people look for. Number one: competitive salary. Number two: tasty food in the cafeteria. Number three: being treated with dignity and respect. And training, the amount of hours you provide employees training.

Those are, statistically speaking, the four factors that drive retention higher. Those companies that meet those are the ones that have the highest rates of retention. We've seen this, that you know a company may try to poach folks, but I think for the most part you have to be very competitive, and we have seen people leave Mack and come back, so you know we're doing a very decent job with that.

MB: Would you say you do most of your training in-house, or are there local or nearby training centers you rely on?

OG: I would say 90% is in-house training, from health and safety to IPC to manufacturing to all kinds of training we provide. Every now and then we rely on outside training services.

MB: Walk me through the process when you move a factory. Do you do it piecemeal line by line, or do you shut everything down on Friday, and on Monday it's all up and running in the new building?

WK: Oscar didn't have any of that gray hair until a few weeks ago. [laughs]

OG: I've done a couple moves in my previous career, but I think it is 90% planning, 10% execution. We were planning

on this move for about 12 months, and we really had a very smooth transition. We moved in three weeks. It was 24/7. We partnered with the right transportation companies, with the right contractors, to set up the new building, and we've been working on this for a number of months. It was lots of planning and making sure we come up with plan A, plan B and plan C. In three weeks, we moved all seven SMT lines, all the box-build and all the warehouses. I think I calculated 100 trips for moving raw materials and equipment, and about 25 trips of heavy equipment, all insured. We had a great transition team. It was very, very stressful at times, but we're working 24/7.

WK: I think Oscar hit on a really important thing. The entire thesis for the expansion in Mexico really boils down to the team. Oscar and his team have done a fantastic job keeping customers happy with very high quality and very predictable delivery, and through the team's efforts they have grown the business substantially. All the indications we have from our customers are they're very pleased with what the team has done, and it's the same team that was in charge of the building move. Again, the team executed very, very well in exactly the fashion we would have expected the team to execute it. The move to the new building really is a vote of confidence in the team because we believe it can continue to grow the business effectively with very high quality and very happy customers.

OG: In the beginning, Mike, you asked what spurred [the move]: seven Supplier of the Year awards in the past four years. It's a great vote of confidence from our customers. High levels of quality, high levels of customer satisfaction. Customers are really happy, and they're giving us more and more business, and we continue growing, and that's how we run out of space in the old facility. Will was kind enough to allow us to continue growing and invest in that growth. There's a lot of reasons, but it's a strong team we have here, very Lean Six-Sigma-oriented, high levels of quality, and that's one of the other factors that contributed to this decision to expand.

MB: When you do move like this, does it trigger any mandatory recertifications or requalifications by customers or ISO?

OG: We did. We partnered with each customer. Each customer is different, and based on each customer's needs, we either provided first-article inspections or a certain level of quality recertification or requalifications. That's from a quality perspective.

From a building perspective, we obviously had to recertify the whole facility and obtain all kinds of permits: the Mexican Environmental Protection Agency, regulatory Federal Electricity Commission, etc. So yes, we were making sure the building complies with all permits.

WK: As far as our ISO certifications, those traveled with us.

OG: Yes, ISO-9000, ISO-13485, those travel with us. Industrial India Cleaning certificate travels; those traveled with us. We will have to recertify in a year, but we retained all of our certs.

MB: I want to talk about how programs migrate through the Mack facilities. Does a given program, if it's sold at Westford, does it stay there, or are they mostly scaling to Juarez?

WK: Every customer's unique, and we've probably implemented every type of structure you can imagine. We always work with the customer to come up with whatever the right structure is for their business and with whatever their needs are. We have likely done every strategy at this point, so we're

The new site is just five minutes from the US border, easing transportation and visitor logistics.

pretty good at pinpointing which ones we recommend to customers, but we work with customers to come up with the right strategy, whether that's launching in the US and transitioning to Mexico, or starting in one site and staying there, or diversifying the business across multiple sites for risk-mitigation purposes. We've seen and done it all. It's a unique situation for each specific customer, depending on what their needs are and the complexity of their own supply chains.

MB: Does each plant have its own procurement group, or is that centralized?

WK: Each plant has its own procurement team responsible for procuring for the specific operation they report into, but we also have senior supply-chain members who oversee supply chain across the whole company.

MB: Do you try to consolidate buys across programs, or is everything program-specific?

WK: We look strategically to make sure our buying practices are getting the best consolidation effort we can, but when we buy parts, buyers buy specific to the customer documentation, and so our strategic supply-chain team looks to essentially consolidate business with suppliers and ensure we're getting the best value we can for our business and our customers. It's a little bit of a hybrid.

MB: Would you, under given circumstances, move material from one factory to another, even if a program isn't moving simply to shore up a shortage?

WK: Absolutely. We will absolutely rebalance materials if it makes sense. We would never do it in a way that would penalize the customer that planned well versus the customer that didn't plan well. Because we use one ERP system, we've built a significant number of tools that allow us to rebalance materials very easily, whether that's to fill shortages or to work with customers to limit material exposure. It's a push of a button to identify where materials can go and, in the reverse way, to say what materials can come in to fill a shortage, if any of the parts are elsewhere within the plant or even within the other Mack plants. It's the beauty of having one IT system.

MB: Do you offer design services at any of your plants?

WK: We offer design for manufacturability and design for test. We don't offer design-from-scratch services.

MB: What benefits or advantages would you say that having the new facility up and running gives Mack and its customer base that didn't previously exist?

WK: Number one, we're going to have significantly more scalability to continue to grow with our customers. Number two, it's more of a purpose-built facility, so we're envisioning significant benefits from being able to apply more Lean manufacturing principles to the new operation that we can hopefully gain efficiencies from. Number three, it's also in a much more central location, so we believe it will actually help us not only retain but attract new talent and make sure we're staying competitive within the Juarez market.

MB: Does this forecast any changes in Florida or Massachusetts in terms of expansion?

WK: We're also potentially looking at expanding in those sites in terms of capacity with equipment. We're seeing significant growth in customer demand essentially across all three of our facilities, the difference being our Florida location has physical space we can still grow into, as does our Massachusetts site, whereas in Mexico we just ran out of physical space.

MB: Do you own the buildings in Florida and in Massachusetts?

WK: We own every building within all of Mack, including Mack Molding, with the one exception being Mexico.

Mexico is our only leased building. We generally don't like leases, but in this particular case the location is so perfect for our operation, this made sense for us.

MB: How are things right now in getting product across the border in either direction?

WK: Across the US-Mexico border, I'd say they are good.

OG: Right. I think it's back to normal. You still have to get product across the international border through customs, and then there's a delay there, but that's come down. During Covid the last 12 or 18 months, we did see a spike, but I think it's back to normal. Both US and Mexico customs have added resources and product flows, so it's not an issue right now.

WK: It's one problem after another bringing product in from overseas right now, whether it's the boat can't reach the port, or the container can't reach the boat, or if the container comes off the boat, then it can't reach the truck or the rail. It's one of the reasons why we really think Mexico is such an appealing option to companies that are looking to supply the North American market. It's a mess trying to bring parts in, and it's become very expensive to bring parts in from overseas.

OG: Everybody is moving toward this; it's common sense. If your customer base is in North America, Mexico is the perfect location to ship from. If your customer base is in Asia, you have Vietnam, you have China, or if you're in Europe you can stay in Slovakia or in an Eastern Bloc country. I think Mexico is really appealing to the largest consumer base in the world, which is the United States and North America. It just makes a lot of sense to be here. ▫

MIKE BUETOW is president of PCEA (pcea.net); mike@pcea.net.

Rethinking the Understencil Cleaning System

Protecting modern-day, complex stencils requires a mechanism overhaul.

AHH, UNDERSTENCIL CLEANING: a necessary – but challenging – aspect of the stencil printing process. I've certainly discussed cleaning in this space before, as the topic bears revisiting when things change. Now is one of those times. As a subprocess of the overall printing operation, understencil cleaning is employed at specific intervals – after "x" number of prints, as determined by the process and the product details – to clear the aperture area of solder paste. Left unchecked, there is a high probability any smear around the aperture will cause defects. This is especially true if printing anything close to microelectronics-level dimensions such as 0402s, fine-pitch BGAs, etc. With these conditions, the likelihood of bridging, solder balling or some form of defect is relatively high without a robust understencil cleaning regimen. To maintain a centered, high-yield process, thorough cleaning of the underside of the stencil between prints "as and when" is required. (There is no standard, "right" number.)

These facts have not changed in many years. What *has* changed are PCB designs, dimensions and electronics assemblers' expectations. As we are all aware, miniaturization has driven stencil thicknesses down to an almost unbelievable 60µm for today's mobile products. That's thin! Modern-day stencils are highly complex tooling components with many tens – if not hundreds – of thousands of apertures cut into a paper-thin piece of stainless steel. The material is delicate, to say the least. With these actualities, it is time to reconsider the mechanisms for ensuring thorough, repeatable understencil cleaning that do not damage the stencil, introduce instability into the process or take too long to perform routine tasks. The industry should rethink the understencil cleaning system needed to manage current and future assembly realities. Aspects to consider include:

Controls and motors. To ensure the cleaning head touches the stencil enough to clean it but not so much as to damage it requires finesse, which is difficult to achieve with conventional on-and-off pneumatic-type motor operation. More sophisticated mechanical systems with a pivot mechanism to provide thorough but gentle contact with the stencil underside, as well as coplanarity, allow for more efficient cleaning without damage. Many of these newer controls that leverage linear motors are also programmable for varying speed profiles and smooth delivery of the cleaning cassette using an independent drive for maximum flexibility and accuracy: for example, the cleaning head moving to the stencil at a rate of 300mm/sec., slowing during the cycle, and returning to home at an increased speed.

Easily managed for changeover. *Poka-yoke,* or "mistake-proofing," is a common term used in Lean manufacturing. The more the chance for human error is reduced, the more defects are reduced and process efficiency raised. Designing stencil cleaning systems that leave no room for interpretation about how to change the fabric roll, for example, and integrate capability like direct drives on the paper to be advanced by stepper motors, improves outcomes, reduces downtime and eliminates the possibility of offline consumable changes eating up too much time.

Fabric and solvent delivery. Maximizing fabric and solvent use through precision movement and deposition reduces consumable costs and ensures repeatability. Systems that can advance enough fresh fabric to the cleaning head with highly accurate solvent dosing delivered on top of the fabric at the proper speed are important. If the fabric is too damp, solvent can penetrate the apertures and the paste roll. Proper dosing is critical, particularly with ultra-fine dimensions.

Prioritization of health and safety. Operator health and safety are of utmost importance, and manufacturers take many measures to protect the manufacturing environment from harmful substances. The understencil cleaning system should be no different. Exhaust from the understencil cleaner may contain solvents and metal particles from the solder paste. Integrating advanced filters ensures the system captures these contaminants and protects workers.

Nonstop performance and integration with frequency optimization tools. Finally, an understencil cleaning system with solvent reservoirs and fabric capacity to go the distance for a full shift vastly improves productivity and yields. When combined with software systems that can determine the optimal "as and when" cleaning frequency, the duration between required cleans can be further maximized.

As I've said many times, the understencil cleaning operation is a process within itself and should be evaluated almost independently of the printer, as the system is integral to achieving printing objectives. Don't overlook understencil cleaning capability and its role in achieving high-quality, high-volume assemblies, particularly in the age of miniaturization and ultra-thin stencils. □

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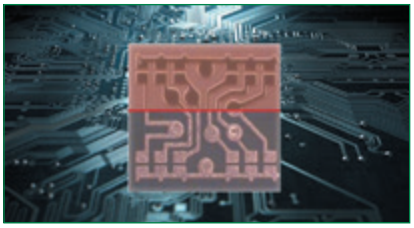

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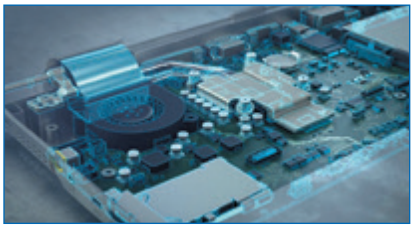

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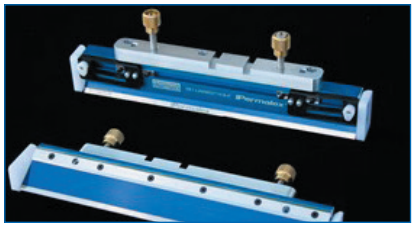

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Permalex Universal holder Rev. 5 improves blade support and simplifies maintenance and blade changes for SMT printer operators. Holder width supporting blade has been increased. Has alloy steel flat head screws. Is available for all models of SMT printers and comes in blue, red, green or silver. Articulating paste retainer design, laser-inscribed part number, optional barcode, and Rev. 3 Permalex Edge design featuring fine edge radius for low force clean wiping.

Transition Automation
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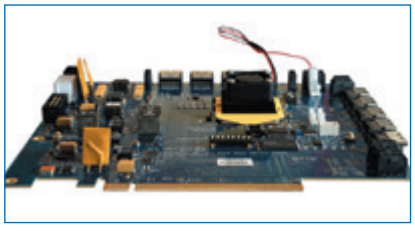

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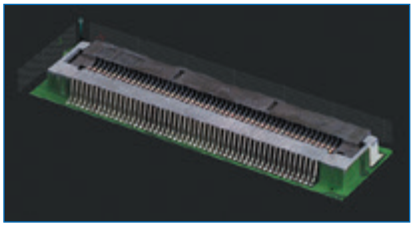

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KFTA3D feeders have built-in OLED screens. Review components before entering machine. Component quantities, feeder slot locations, part numbers and part values are stored directly on feeders and updated. Have internal batteries. Vision library names displayed. Store lot and date codes. Compatible with all 2022 MC-series pick-and-place machines.

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EP35AOLV two-part heat-cured epoxy is for bonding, sealing, coating and potting applications. Is a thermally conductive, electrically insulating compound that withstands aggressive chemicals. Protects against corrosion in various harsh environments. Service range that extends from -60°F to 500°F (52°C to 260°C) and a glass transition temperature of 165-170°C; is resistant to high temp. Thermal conductivity value is 7-8 BTU•in/(ft^2 •hr•°F) [1-1.15 W/(m•K)]. Compressive strength measures 24,000-26,000psi. Has good dimensional stability and low shrinkage upon curing. Ideal cure schedule is 2 to 3 hr. at 300°F, followed by 3 to 4 hr. at 300-350°F. Has 100 to 50 mix ratio by weight and is flowable, with a mixed viscosity of 50,000-90,000cps. Adheres well to substrates such as metals, composites, glass, and high-temp. plastics.

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KURTZ ERSA EXOS 10/26 CONVECTION REFLOW SOLDERING

EXOS 10/26 convection reflow soldering system has vacuum chamber of 600mm to handle PCBs with max. length of 600mm. Offers 22 heating and four cooling zones, as well as vacuum chamber after peak zone to remove voids in solder contact areas between component and PCB surfaces. Reportedly has excellent process reliability and ease of maintenance.

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In Case You Missed It

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.

Flexible Electronics

"Microwave Flexible Electronics Directly Transformed from Foundry-Produced, Multilayered Monolithic Integrated Circuits"

Authors: Guoxuan Qin, *et al.*

Abstract: Monolithic microwave integrated circuits hold a dominant position in telecom applications, especially in mobile devices with capabilities for wireless connectivity, due to high and repeatable performance, compact form factor, and low cost. With flexible electronic technologies forming the foundation for a rapidly growing wearable and implantable device segment, the need for flexible microwave electronics with levels of performance that match those of rigid counterparts has increased to unprecedented levels. Here, the fabrication processes for transforming a rigid form of foundry-produced, multilayered monolithic microwave integrated circuit into a flexible format for amplification of radio frequency signals in the gigahertz level are described. The strategy involves a complete replacement of all rigid materials in the integrated circuit that do not provide any active electronic functionality with a soft, silicone elastomer to yield an overall structure that is mechanically compliant. Experimental studies indicate the transformation process leads to a flexible silicon-germanium-based heterojunction bipolar transistor with a maximum oscillation frequency of 49GHz and a 24GHz amplifier with a small-signal gain of 13.2dB. This approach has potential uses across a diverse set of microwave devices and circuits in a manner that could enable wireless connectivity using entirely flexible electronics. (*Advanced Electronic Materials,* March 2022, https://onlinelibrary.wiley.com/doi/10.1002/aelm.202101350)

"Green Flexible Electronics Based on Starch"

Authors: Huacui Xiang, *et al.*

Abstract: Flexible electronics with excellent flexibility or foldability may find widespread applications in wearable devices, artificial intelligence, Internet of Things, and other areas. However, wide utilization may also bring concern for the fast accumulation of electronic waste. Green FEs with good degradability might supply a way to overcome this problem. Starch, as one of the most abundant natural polymers, has been exhibiting great potentials in the development of environmentally friendly FEs due to its inexpensiveness, good processability, and biodegradability. In this review, the authors discuss the preparation and applications of starch-based FEs, highlighting the role played by the starch in such FEs and the impacts on the properties. Finally, the challenge is discussed, and the outlook for further development is presented. (*NPJ | Flexible Electronics,* March 2022, www.nature.com/articles/s41528-022-00147-x)

Printed Electronics

"AI-Assisted Reliability Assessment for Gravure Offset Printing System"

Authors: Anton Nailevich Gafurov, *et al.*

Abstract: In printed electronics, flawless printing quality is crucial for electronic device fabrication. While printing defects may reduce the performance or even cause a failure in the electronic device, there is a challenge in quality evaluation using conventional computer vision tools for printing defect recognition. This study proposed the computer vision approach based on artificial intelligence and deep convolutional neural networks. First, the data set with printed line images was collected and labeled. Second, the overall printing quality classification model was trained and evaluated using the Grad-CAM visualization technique. Third and last, the pretrained object detection model YOLOv3 was fine-tuned for local printing defect detection. Before fine-tuning, ground truth bounding boxes were analyzed, and anchor box sizes were chosen using the k-means clustering algorithm. The overall printing quality and local defect detection AI models were integrated with the roll-based gravure offset system. This AI approach is also expected to complement more accurate printing reliability analysis firmly. (*Scientific Reports,* February 2022, www.nature.com/articles/s41598-022-07048-z)

RFID

"Metamaterial-Enhanced Near-Field Readout Platform for Passive Microsensor Tags"

Authors: Ke Wu, *et al.*

Abstract: Radiofrequency identification (RFID), particularly passive RFID, is employed in industrial applications to track and trace products, assets, and material flows. Miniaturization RFID sensor tags present a challenge with regard to the communication coverage area. Recently, efforts in applying metamaterials in RFID technology to increase power transfer efficiency through their unique capacity for electromagnetic wave manipulation have been reported. In particular, metamaterials are being increasingly applied in far-field RFID system applications. Here, the authors report the development of a magnetic metamaterial and local field enhancement package enabling a marked boost in near-field magnetic strength, ultimately yielding a dramatic increase in the power transfer efficiency between reader and tag antennas. The application of the proposed magnetic metamaterial and local field enhancement package to near-field RFID technology, by offering high power transfer efficiency and a larger communication coverage area, yields new opportunities in the rapidly emerging IoT era. (*Microsystems & Nanoengineering,* March 2022, www.nature.com/articles/s41378-022-00356-4)

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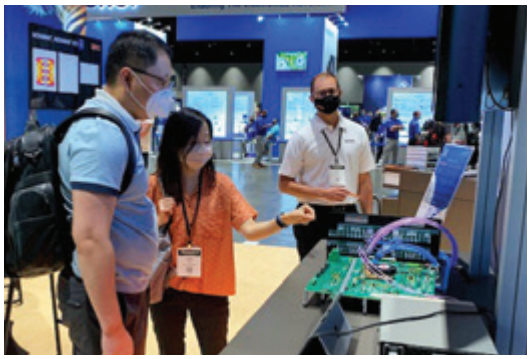

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