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DESIGNING ELECTRONICS NORTH AMERICA

NOVEMBER/DECEMBER 2025

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WHAT DOES THE FUTURE HOLD?

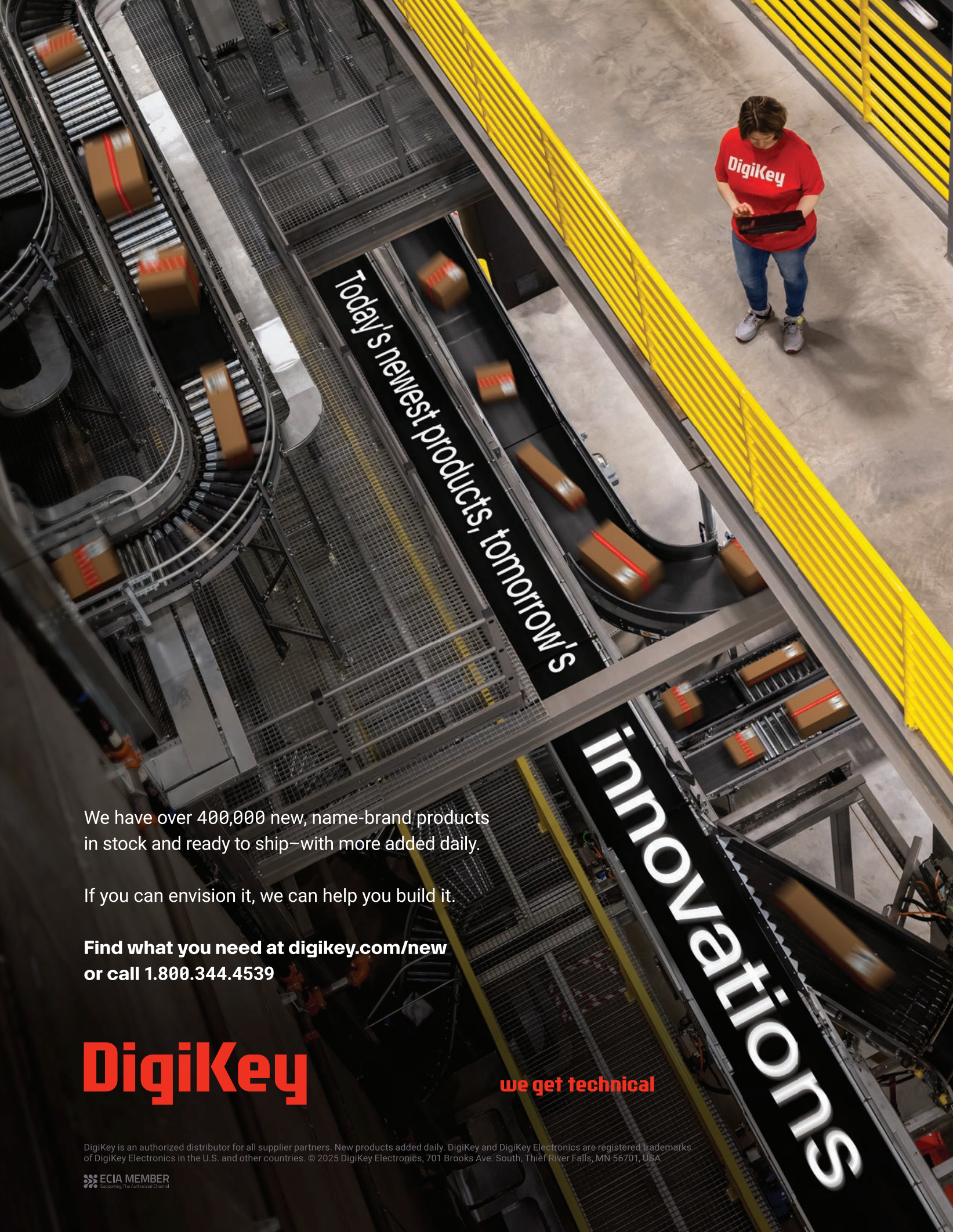
HARDWARE, SOFTWARE, ANALOG, DIGITAL, DESIGN AND TEST

DENA REVEALS THE PATH AHEAD

+

ALSO FEATURED EXECUTIVES PROVIDE THEIR OUTLOOKS FOR 2026 **PAGES 26 & 27**

EXECUTIVE FORECASTS 2026



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CONTENTS



08 SEMICONDUCTOR
The race for the next great semiconductor material



14 HIGH-RELIABILITY COMPONENTS
Navigating high-reliability and COTS component sourcing



18 CONNECTIVITY
The key to smarter, safer access control



22 SECURITY
Why stealing automotive ECU firmware is surprisingly easy

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EDITOR'S WORD



Speeding into tomorrow

With this issue of DENA, we are quickly approaching the end of 2025. This means we're poised to enter the second quarter of the 21st century!

If we consider things in 25-year chunks, we realize that 1975, 2000, and 2025 sit at very different points in the technology timeline. The hottest technologies in 1975 included early microprocessors, home computers (which were just starting to emerge), video games (the 1972 release of Pong had created a craze; by 1975, arcade machines were booming), digital watches, pocket calculators, and similar devices. By comparison, the hottest technologies in 2000 included the internet, mobile phones, MP3 players and digital music, broadband and Wi-Fi, PCs and gaming, and digital cameras. And now…

It's not your imagination—the pace of technological development is accelerating. New breakthroughs don't happen in isolation. AI, sensors, connectivity, and cloud computing amplify each other, accelerating innovation. In 1975, ideas spread through journals, conferences, and snail mail. Today, research is published instantly online while code is shared on GitHub. What once required a million-dollar laboratory can now be accomplished with just a laptop and an internet connection.

Innovations today stack and build upon one another. The technology frontier is less about one invention at a time (like the microprocessor in 1971) and more about ecosystems of rapid breakthroughs. What will the second quarter of the 21st century bring? I have no idea, but I'm excited to find out. And, as always, you can rest assured that whatever does come our way, the team at DENA has you covered.

Max Maxfield

CLIVE 'MAX' MAXFIELD
Editor, DENA

DENA
DESIGNING ELECTRONICS NORTH AMERICA

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TOP STORY

Space-saving solid-state relays

Littelfuse has announced the expanded offering to its industrial Solid-State Relays (SSRs) family of products. The additional three series of products and accessories are essential for industrial applications that demand reliable and compact switching and comply with international standards.

The new SSRs are available in three configurations plus added accessories: SRP4-CC (four relays in one, 4-pole design saves space by controlling multiple AC loads instead of using separate relays), SRP1-KC (Slim, low-profile that's half the size of standard relays featuring faston terminals for easier installation), and SRP1-ME (small size, ¼ the size of a standard relay, for space-constrained applications).

Typical applications for these products include industrial machinery (ovens, sterilization systems, plastic sealing and packaging equipment...), HVAC (electric heaters, steam and spa equipment...), and food & beverage (coffee machines, ovens, commercial fryers...)

www.littelfuse.com



Motor drivers

Melexis has introduced the MLX81339, a new embedded motor driver with PWM/Serial interface. This IC is designed for compact 3-phase BLDC and stepper motor control up to 40W in industrial applications such as fans, pumps, and positioning systems. Its programmable flash memory enables full application customization.

The device supports control up to 20W at 12V and 40W at 24V, integrating a 3-phase driver with a configurable current limit of up to 3A, as well as under/overvoltage, overcurrent, and over-temperature protection to ensure reliable operation.

For applications requiring flexibility in configuration, the MLX81339 offers Flash programmability while maintaining a small footprint. These advanced drivers use silent, efficient field-oriented control (FOC) and ensure reliable startup, stopping, and precise speed control from low to maximum speed.

www.melexis.com

Ultra-compact DC-DC converters

XP Power has announced the launch of the BCT40T series of cost-effective 40W DC-DC converters, housed in an industry-leading 1" x 1" (25.4mm x 25.4mm) compact package designed for PCB mounting. This new series offers high power density and a comprehensive set of features, making it an ideal power solution for a wide range of demanding industrial technology, ITE, and communications applications where space is a critical constraint.

The BCT40T series features high efficiency, up to 89% depending on the model. It is designed for wide operating temperatures, ranging from -40°C to +105°C, and a broader full-load operating temperature range compared to many alternatives. For enhanced system control and safety, the series features remote on/off functionality, enabling energy savings and safe shutdowns.

www.xppower.com





Universal enclosure feet kits

METCASE's TECHNOFEET kits for electronic enclosures are now available in traffic gray A (RAL 7042), complementing the existing light gray (RAL 7035), anthracite (RAL 7016), and black (RAL 9005) options.

These stylish universal case feet are designed to fit all types of metal and plastic enclosures from METCASE and other manufacturers, as well as existing OEM equipment housings that require tough, modern anti-skid feet.

Two separate TECHNOFEET kits are available, enabling them to be specified with or without tilt legs for canting the enclosure to a more comfortable viewing angle.

Each round ø1.18" x 0.47" foot comprises an ABS (UL 94 HB) body, an anti-skid TPE pad, and a self-tapping screw. Each kit includes four foot moldings, four pads, and four screws. The tilt leg kit also includes the two hinged legs, which have a 120° rotation. When folded flat, they extend 1.52" beyond the circular foot.

www.metcaseusa.com

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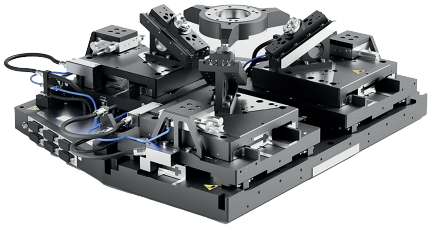
Wi-Fi HaLow occupancy sensor

Airfide Networks has announced the availability of the next generation of its AFN6843 micro-mobility occupancy sensor, now enhanced with Wi-Fi HaLow connectivity. The new sensor integrates Morse Micro's MM6108 Wi-Fi HaLow SoC. This enables 10x better coverage distance than Wi-Fi 4/5/6/7 while maintaining ultra-low power and high reliability for commercial and industrial IoT deployments.

Key features include long-range wireless with sub-GHz Wi-Fi HaLow, enabling whole-building coverage; edge AI detection of occupancy, presence, motion, fall events, and more; non-intrusive sensing using mmWave radar sensor for people counting and angle information; cloud platform for live monitoring and actionable insights; and Android and Apple iOS applications for real-time monitoring and deployment.

Use cases include smart buildings and offices (automate HVAC and lighting, optimize desk usage, monitor occupancy density), healthcare and aged care (fall detection, inactivity alerts, presence monitoring without compromising privacy), retail and public spaces (people counting, dwell time analytics, queue monitoring, and heatmaps), and industrial and logistics (worker tracking in hazardous zones, object detection, zone safety compliance alerts).

www.airfidenet.com



6-axis motorized automation platform

PI (Physik Instrumente) has announced the release of the F-690.S1 SpaceFAB, a high-performance 6-axis motorized positioning stage platform, designed for advanced automation tasks that demand high speed, precision, and reliability.

The F-690.S1 is built on a unique hybrid kinematic design featuring three symmetrically arranged XY nanopositioning stages with direct-drive linear motors and cross-roller bearings. Each stage supports a linear bearing mounted on a wedge with ball-joint connections, enabling full 6-degree-of-freedom motion (X, Y, Z, pitch, yaw, roll) with smooth coordination and minimal mechanical crosstalk.

Features like software-defined pivot points ("Pivot Anywhere") make the F-690.S1 adaptable to a wide range of automation tasks — from micro-assembly and PIC component testing to high-precision metrology — where multi-axis accuracy and throughput are critical.

www.pi-usa.us

Novel stacked capacitors

KYOCERA AVX has released the new DSCC 25007 Mini BME Stacks — miniature, high-CV stacked X7R capacitors equipped with base metal electrodes (BME) and subjected to 100% Group A testing.

Designed to meet the growing demand for compact and lightweight high-CV SMT capacitors in high-reliability military, aerospace, and space applications that operate under extreme conditions and harsh environments, the new fully tested and traceable DSCC 25007 Mini BME Stacks are based on its proven MIL-PRF-32535 X7R capacitors, but are completely unique to the market.

Ideal applications for the series span the military, aerospace, and space industries, including satellites and satellite launchers, military missiles and aircraft, as well as input/output filtering circuits in power supplies.

www.kyocera-avx.com





Compact puck antennas

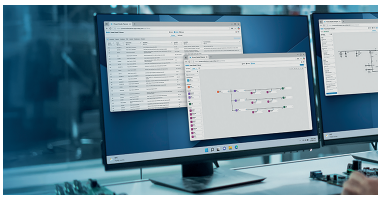
Taoglas has announced the expansion of its Comet Series with the new MA58x family of compact, discrete, screw- or through-hole mount puck antennas. Metal structures or flat surfaces, such as cabinets, can impact antenna performance and alter the electrical ground plane. The Comet MA58x Series is specifically engineered to maintain stable, high-efficiency operation in these challenging conditions.

With a footprint of just 101 x 101mm and a super-low profile of only 20mm, the antennas deliver reliable multi-antenna connectivity across 5G/4G MIMO, Wi-Fi 6/7, and GNSS constellations, including GPS, GLONASS, Galileo, and BeiDou.

Advanced RF design enables consistent gain and efficiency across global cellular frequencies from 600 MHz to 6 GHz and Wi-Fi bands up to 7.125 GHz, while also supporting legacy 2.4/5.8 GHz Wi-Fi and Bluetooth for maximum compatibility. These levels of performance are rarely achieved in antennas of this size, and even more so when installed on metallic structures.

www.taoglas.com

Power design tools



Analog Devices has launched ADI Power Studio, providing engineers with a unified workflow:

Plan: Explore system-level architectures with power tree diagrams that calculate and optimize voltage rails, load currents, and supply paths, delivering early insights that accelerate validated solutions.

Design: Once the architecture is defined, explore IC-level designs with tools to speed component selection while maintaining key performance parameters.

Simulate: Simulating design performance plays a pivotal role in streamlining development and speeding time to market.

Configure: Once an initial design configuration has been established, the process of executing diagnostics, resolving system-level issues, and refining performance parameters begins in earnest.

Measure: With a hardware power design in hand, it's time to take real-world bench measurements to confirm performance requirements are achieved.

www.analog.com

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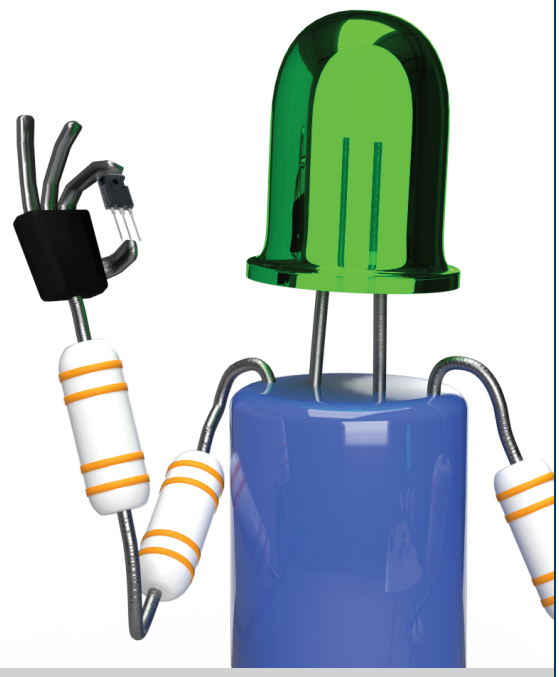
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Beyond silicon

The race for the next great semiconductor material

by **Caitlin Ryan,** Scientific Writer at **Ossila**

For decades, Moore's Law—the doubling of transistors on a chip every two years—has defined progress in computing. However, with transistors now operating at atomic scales and quantum effects causing power and thermal issues, the path forward depends on new materials, not just smaller silicon.

Gallium Nitride

It's impossible to discuss the next generation of semiconductors without bringing up Gallium Nitride (GaN). As a wide-bandgap material, GaN thrives in high-frequency, high-power applications where silicon struggles. It has high electron mobility, enabling rapid switching capabilities, and superior thermal performance that addresses heat dissipation issues. Additionally, GaN is widely recognized for its superior power performance, enabling the creation of more efficient transistors and ultimately smaller systems.

Silicon Carbide

Silicon Carbide (SiC) is another wide-bandgap powerhouse, and it's the closest that we currently have to mainstream adoption. Again, SiC handles far greater voltages than silicon, but also has the advantage of being durable, making it ideal for use in harsh environments, such as industrial systems and aerospace applications.

SiC's most significant opportunity lies in electric vehicles (EVs), where efficiency and heat resistance are particularly important. As such, the SiC market is projected to hit $4.5 billion by 2027, making it one of the fastest-growing segments in the semiconductor industry.

2D materials

At the cutting edge of semiconductor research are 2D materials which are atomically thin layers with extraordinary electrical, optical, and mechanical properties. The most well-known of these is graphene, a single layer of carbon atoms in a hexagonal lattice that's stronger than steel, nearly transparent, and boasts electron mobility up to 100 times that of silicon. These traits make it an ideal candidate for futuristic applications, such as flexible electronics and high-sensitivity sensors.

We're not quite there yet

Silicon dominates the industry for a reason. After decades of refinement, manufacturing is fast, cheap, and highly optimised. Switching to a new material isn't just a simple upgrade; it's a complete reset that requires new processes and tools. That's an expensive gamble for an industry that is built on scale and predictability. Silicon is also abundant and easy to source, unlike many next-generation materials that depend on rare elements or volatile by-products, such as GaN's reliance on aluminum and zinc mining.

Compatibility issues may be one of the biggest hurdles to overcome. Even if tomorrow's semiconductors outperform silicon, they still need to fit into a world that's built for silicon. For now, the industry is leaning on hybrid solutions, where new materials are layered onto existing silicon chips. It's a clever workaround, but it adds design complexity, introduces new points of failure, and forces engineers to rethink decades of assumptions about transistor architecture.

The road ahead

Looking forward, the semiconductor landscape is unlikely to shift overnight. What will decide the winner? It'll come down to more than just performance, and manufacturing economics will determine whether a material is viable on the massive scale that the semiconductor industry demands.

Silicon isn't going anywhere soon, but as demand for higher efficiency grows, we'll start to see these new materials increasingly take centre stage in specific applications.

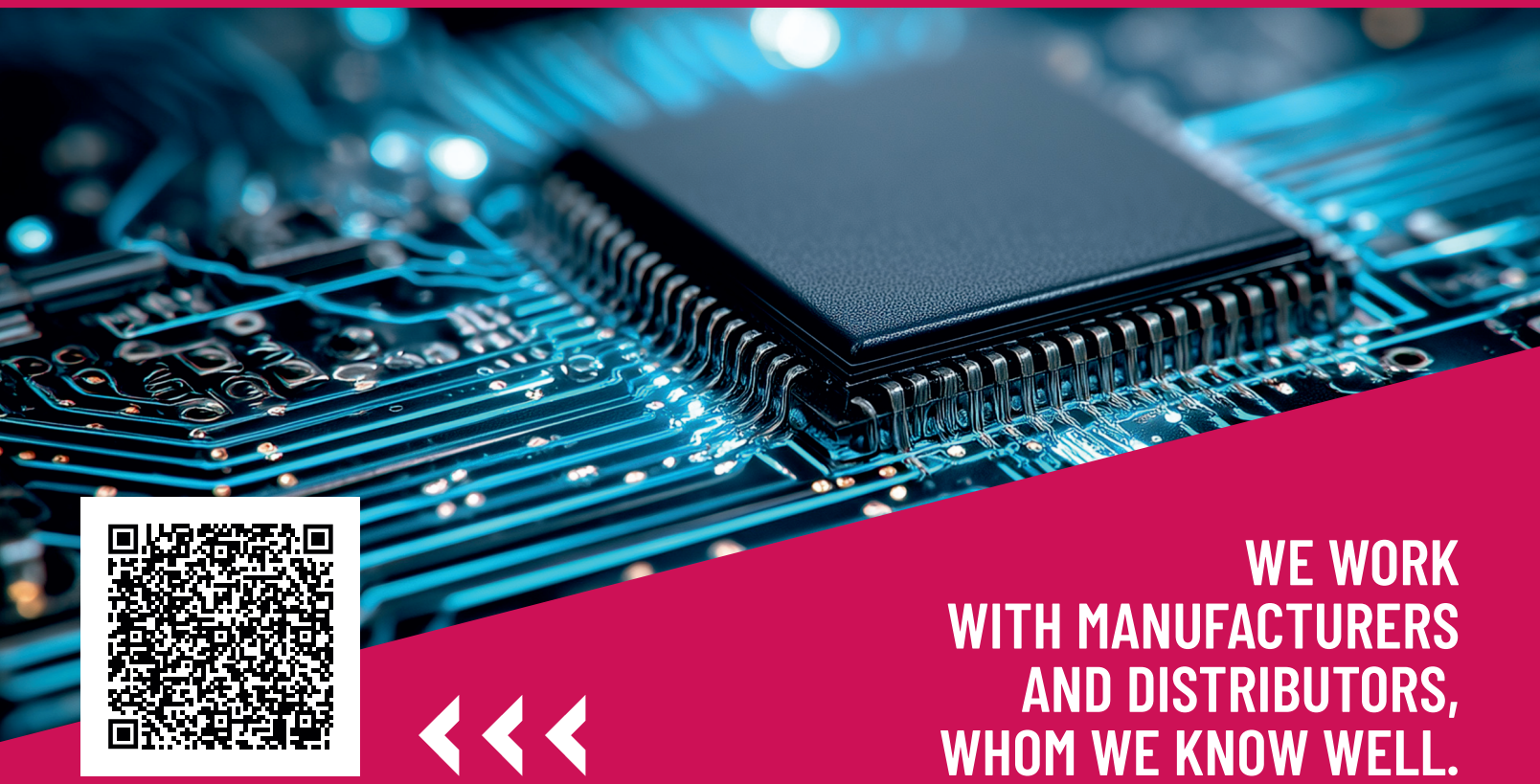
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NewSpace trends do not obviate the need for high-reliability ceramic capacitors



Cutting corners on capacitors may save dollars today, but it risks space equipment tomorrow

by **Daniel West,** Lead Technical Applications Engineer, **KYOCERA AVX**

There's a growing momentum among some members of the space industry community to push less-than-space-grade multilayer ceramic capacitors (MLCCs) to their limits to reduce the costs associated with entering space.

The commercialization of space and recent success stories make it easy to adopt a BOM with components rated for automotive applications and even readily available commercial-grade components to accommodate projects with extremely short design cycles like LEO constellation satellites. What makes it even easier to adopt these components is that the relative price of an automotive-grade capacitor compared to a space-grade capacitor can differ by one or two orders of magnitude.

When we consider the emerging power demands of AI processing cores and the amount of capacitance required for decoupling, the costs go up dramatically. It's completely understandable why this NewSpace (private spaceflight) trend of pushing readily available commercial/automotive-grade components to their limit is growing and seems to be proliferating to the general space community as well, but it's also understandable when suppliers won't accept the liability of launching those parts into space.

This trend should prompt questions from NewSpace component engineers to high-reliability MLCC manufacturers to determine what is truly purchased from one level of reliability to another, but it can also prompt requests for an expedited root cause analysis of failed parts, followed by questions to determine what actually separates different tiers of reliability. This request for failure analysis may be rejected because commercial- and automotive-grade parts typically do not require burn-in. Since burn-in is intended to filter out parts with latent defects that can go undetected with standard electrical testing, it would be a waste of resources to test parts that accept a much higher early-life failure rate.

For those looking to use non-space-grade components for their space applications, it's worthwhile to bring up some additional items that will foster meaningful discussions with ceramic capacitor manufacturers.

The effort to characterize the reliability of an MLCC is extremely difficult and time-intensive. Additionally, if there is a design change or equipment optimization for a given MLCC design, the tests should be run again. Much of this effort has already been undertaken by manufacturers specializing in supplying components for high-reliability applications.

High-reliability devices are typically built to a MIL-PRF-XXXXX document, a DLA/DSCC drawing, or the qualification standards of a space agency, such as NASA/ESA. There's a lot of paperwork involved, but these documents essentially require manufacturers to comply with a list of tests to be an approved supplier. The sample sizes for these tests are typically much larger (if not 100%) than other reliability grades and have stricter pass/fail criteria than automotive- and especially commercial-grade parts. A wide range of tests can also be added, removed, or modified from these documents to accommodate custom designs, known as Source Control Drawings (SCD). Some special test examples would be radiation testing, cryogenic tests (< 77 kelvin), tin whiskers, out-gassing, hermeticity, and harsh shock/vibration tests.

Automotive-grade reliability is the next significant reliability level below MIL/Space/Aerospace components. These MLCCs are designed to meet the requirements outlined

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KYOCERA AVX

FROM LAUNCH PAD TO DEEP SPACE

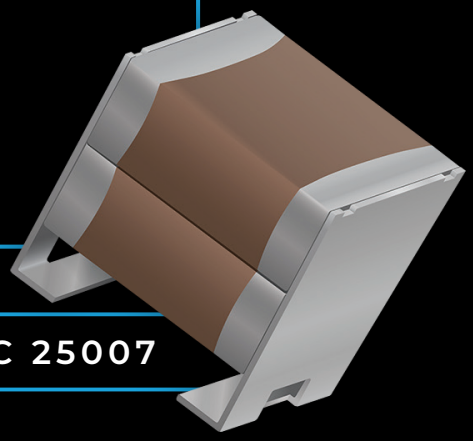


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DSCC 25007

To learn more about KYOCERA AVX's full component portfolio please visit **www.kyocera-avx.com**

in the AEC-Q200 document and are also intended to support an industry with extremely large volumes. As a result, MLCC designs are optimized to strike a balance between yield and quality, while remaining competitive in the market. For example, life tests for automotive-grade parts last 1,000 hours, which is the same as those for commercial-grade components. The availability would plummet if they complied with 4,000-hour life tests outlined for high-reliability grade parts, not to mention the increased costs associated with "keeping the lights on."

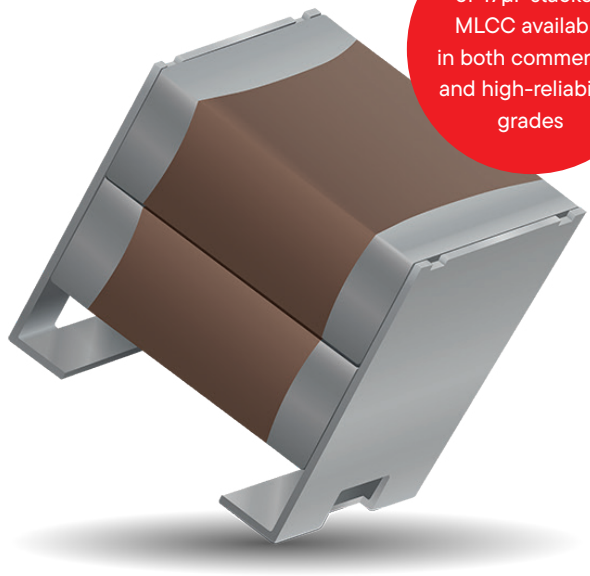
Commercial-grade reliability is where the majority of the MLCC global volume resides. Billions of people hold a few hundred MLCCs in their hands every day when looking at their mobile phones. Testing on these components is limited to small sample sizes and to check for basic electrical, thermal, and environmental performance. Cost efficiency and availability are paramount over reliability; therefore, limited notifications are sent to customers when a design change occurs. Capacitance, dissipation factor, and insulation resistance are the primary electrical parameters checked when inspecting commercial-grade MLCCs. Again, burn-in is not performed, meaning a larger ratio of parts with latent defects will be shipped because this is acceptable for short-life or redundant applications. Between commercial-, automotive-, and space-grade designs are huge jumps in requirements that are pushed to suppliers for monitoring process inputs that are impossible to see with the naked eye. The subtle differences are even difficult to discern with comprehensive DPA (destructive physical analysis) and imaging technology, unless you know what to look for.

Take, for example, the KGP (commercial-grade) and DSCC 25007 (high-reliability-grade) stacked MLCCs from Kyocera-AVX. Both use discrete MLCCs attached to a lead-frame to increase capacitance. They look very much alike and provide identical circuit functions, but the DSCC 25007 is designed to provide many years of use with confidence in adverse electrical, mechanical, and thermal conditions, whereas the lifetime of commercial-grade products relies on multiple factors at a much lower confidence level.

Commercial-grade MLCCs typically qualify for lifetime use after a 1,000-hour test at rated voltage and temperature. You can derate them and use Arrhenius to estimate an extended lifetime, but the results will vary significantly from lot to lot. You'd also have to find a supplier willing to determine accurate activation energies from HALT (Highly Accelerated Life Test) analysis for commercial-grade parts, but the likely response will be that they send you to their space-grade parts, where this request for HALT is more reasonable.

NewSpace trends, including short design cycles, cost reduction, and a higher tolerance for asset loss in non-critical missions, have revealed that there is no fully dedicated reliability grade of MLCCs for this emerging industry. Some passive electronic component manufacturers are responding to this trend with enhanced COTS (Commercial Off-The-Shelf) components. These are defined and handled differently among suppliers because there is no independent governing agency; therefore, a close conversation with them is needed to determine if they're performing burn-in on commercial/automotive-grade devices, conducting statistical screening of standard tests, using a unique design, or simply limiting tests of high-reliability devices to meet demands. With this information, a cost-versus-risk analysis for a NewSpace project would be much more accurate.

www.kyocera-avx.com

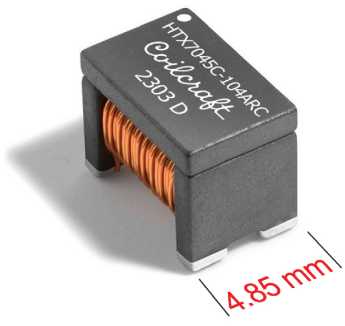


Render of 47µF stacked MLCC available in both commercial and high-reliability grades

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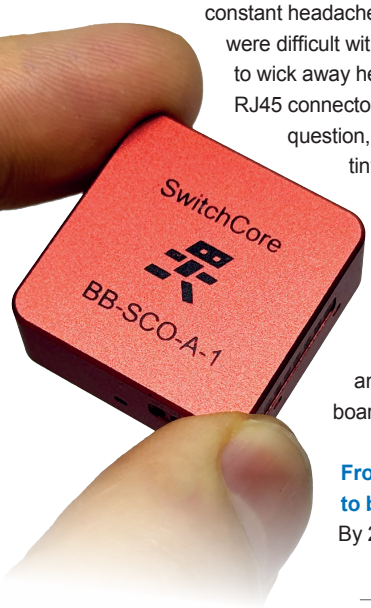
by **Josh Elijah:** Founder & CEO, **BotBlox**

I am obsessed with making tiny electronics. I love cramming as much functionality as possible into a package that is small, low power, and almost invisible within a system, yet often providing the "smarts" that make the whole device work. That obsession led me to design miniature Ethernet routers, and eventually, almost by accident, to building a multi-million-dollar business.

The first step

My first foray came while working on a robot for hazardous waste inspection. The design called for four GigE cameras connected to a Raspberry Pi, all within a footprint no larger than two inches square. I was tired of gutting off-the-shelf Netgear routers and grinding down fiberglass PCBs to make them fit, so I designed my own 5-port gigabit Ethernet switch stripped down to the essentials.

Miniaturizing it was tough. High-speed traces competed for space, and crosstalk became a constant headache. Thermal problems were difficult without enough copper to wick away heat. Standard RJ45 connectors were out of the question, so I turned to tiny Molex headers. Eventually, it worked beautifully. I ordered 100 boards, threw together a website, and named the board GigaBlox.



From side project to business

By 2020, sales were trickling in, and some surprisingly big names appeared among the customers. After Russia invaded Ukraine, the demand for drones spiked. Engineers discovered that Ethernet, originally for offices and data centers, was rugged and ideal for harsh environments. Orders multiplied, and I realized I had stumbled into a business with enormous potential.

I founded BotBlox, and the product line quickly grew. Today, we sell more than 16 miniature networking modules, each designed to bring reliable connectivity to drones, robots, and edge systems. However, my proudest achievement is something still in development—a project that pushes miniaturization even further: SwitchCore.

Introducing SwitchCore

SwitchCore is an 8-port, 10/100 Mbps Ethernet switch and router in a stackable form factor, measuring just 1 inch by 1 inch by 0.5 inches. Holding it between your fingers, it looks like a piece of jewelry, yet it delivers the same functionality as a desktop networking appliance.

The design was anything but simple. Standard Ethernet switch chips were too large, so I turned to a Lattice iCE40 FPGA, which is just 14 × 14 mm, and wrote custom Verilog code to implement Ethernet switching. This gave me the freedom to strip out unnecessary functions, keeping the system lean and efficient.

Powering the FPGA was another hurdle. In the past, multiple DC-DC regulators and external inductors would have been required. However, new single-chip regulators with integrated inductors elegantly solved that problem, keeping the design compact and power-efficient. Gotta love semiconductor progress!

Why a router?

An Ethernet switch connects devices inside a single local network. A router sits one layer above, using IP addresses to connect multiple networks and route traffic intelligently. Why does this matter in a drone or robot?

Due to advanced features, including VLANs, firewalls, and quality-of-service rules, engineers can effectively control data flow. You may want to isolate a drone's radio system from its internal sensor network for security purposes or prioritize vision data over telemetry. Only a router can do that, and nothing this small has existed until now.

Making it work

To add ethernet routing, I integrated a tiny STM32 microcontroller, running Zephyr OS on just 0.2W. My brother, a firmware engineer, built a command-line interface from scratch. The design consists of two PCBs connected by a flex cable and enclosed in a CNC-milled aluminum chassis that doubles as shielding and a heat spreader.

It works, but it's not yet finished. The switching is still buggy, and the mechanical stability of such tiny PCBs remains a challenge. Yet SwitchCore represents a glimpse of the future. When embedded networking hardware can be reduced to a cubic inch, new generations of drones and robots can be made smaller, smarter, and far more capable.

For me, SwitchCore is more than a product; it embodies everything I've been working on for the past six years and what I love about miniaturization: the challenge, the intricacy, and the potential to change what's possible.

www.botblox.io

Navigating high-reliability and COTS component sourcing



Manufacturing teams must strike a balance between technical performance and supply chain realities

by **Lew LaFornara,** SVP Product & Supplier Marketing at **TTI IP&E, Americas**

In 2025, the sourcing landscape for electronic components continued to be affected by global supply chain disruptions, shifting geopolitical dynamics, tariffs, and the accelerating pace of technological innovation. For engineers working in sectors where reliability is paramount, such as aerospace, defense, medical, transportation, and energy, the challenge goes beyond specifying the right part. It's about understanding how sourcing decisions impact system integrity, lifecycle planning, and long-term availability.

At TTI, we've seen firsthand how engineers are increasingly involved in sourcing conversations, particularly when high-reliability components face extended lead times and obsolescence. The collaboration between design and procurement is increasing, as engineers are being asked to evaluate alternatives, including commercial off-the-shelf (COTS) components.

The reliability imperative

High-reliability, commonly referred to as Hi-rel, components are engineered to perform under extreme temperature fluctuations, vibration, radiation, corrosive, and otherwise hostile environments. These parts are typically qualified to various standards and specifications, depending on the industry and application, such as defense, space, transportation, medical, and energy. Hi-rel components undergo rigorous screening and testing. In mission-critical applications, failure is not an option; therefore, engineers prioritize these components to ensure both safety and performance.

The sourcing environment for these parts is becoming increasingly complex, with supplier reliability and cost volatility being among the top concerns for procurement teams. Together, the manufacturing team must consider not only the technical fit of a component but also its supply chain resilience.

COTS components: a viable alternative?

COTS components have traditionally been viewed as not suitable for high-reliability applications. It seems that this perception is changing. Advances in manufacturing quality, traceability, and lifecycle data have made certain of these components increasingly viable for use in non-critical subsystems and controlled environments.

Notably, our experience supporting defense and aerospace customers demonstrates that COTS MLCCs, resistors, and polymer capacitors are being increasingly evaluated for higher-reliability use cases. Engineering teams are asking: "Can this part meet the performance requirements with additional screening?" "Is the supplier's quality system robust enough?" And "What are the long-term risks?"

These are valid questions, and the answers depend on context. For example, in space applications, engineers may accept COTS ceramics with enhanced dielectric stability and documented radiation tolerance. In transportation, where vibration and temperature extremes are common, COTS parts may be acceptable if they meet AEC-Q200 standards and are sourced through authorized channels.

Engineering's role in sourcing strategy

When procurement teams suggest COTS alternatives, engineers should conduct a

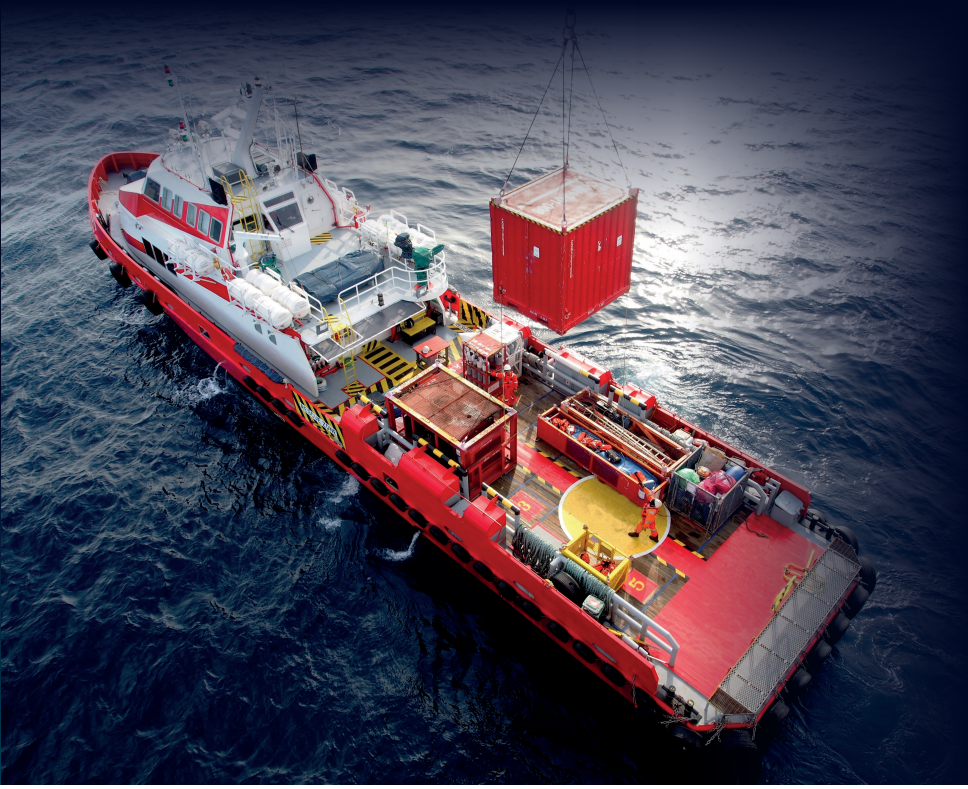
structured evaluation, reviewing the datasheet, supplier quality certifications, and available reliability testing. Ask whether additional screening, like burn-in or temperature cycling, can close the gap between commercial and high-reliability standards.

A trusted resource in distribution can often support customer engineering teams in this process by providing insight into product roadmaps, lifecycle status, and supplier capabilities. The goal is not to replace high-reliability components, but rather to help engineers make informed decisions when alternatives are needed due to cost, availability, or program constraints.

Lifecycle planning and obsolescence

A frequently overlooked aspect of component selection is lifecycle alignment. Defense and industrial systems often operate for decades, while component lifecycles may span only a few years. This mismatch creates sourcing challenges that should be anticipated.

Your trusted supply chain resource should include an inventory model built to support long-lifecycle programs, with strategic stocking and supplier partnerships that mitigate obsolescence risk. Engineers can benefit from engaging with distributors early in the design phase to identify parts with stable supply and long-term availability.



Conclusion

In today's sourcing environment, manufacturing teams must strike a balance between technical performance and supply chain realities. High-reliability components remain essential for critical applications, as does a supply chain model that includes proactive inventory management programs to help prevent and mitigate production disruptions. However, a COTS alternative, when properly vetted, can offer flexibility and resilience when needed. By collaborating with procurement and leveraging distributor expertise, engineers can design systems that are not only reliable but also sustainable and manufacturable.

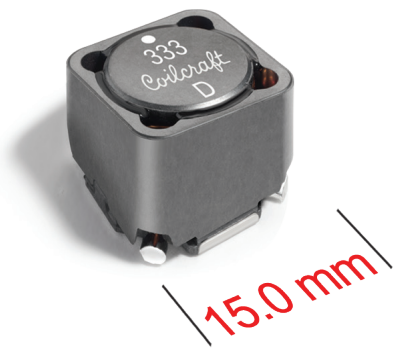
At TTI, we're committed to supporting engineers with the data, insights, and inventory needed to make confident sourcing decisions. Whether you're building satellites, electric vehicles, defense systems, or oilfield equipment, we're here to help you navigate the complexities of component reliability today and for the life of your program.

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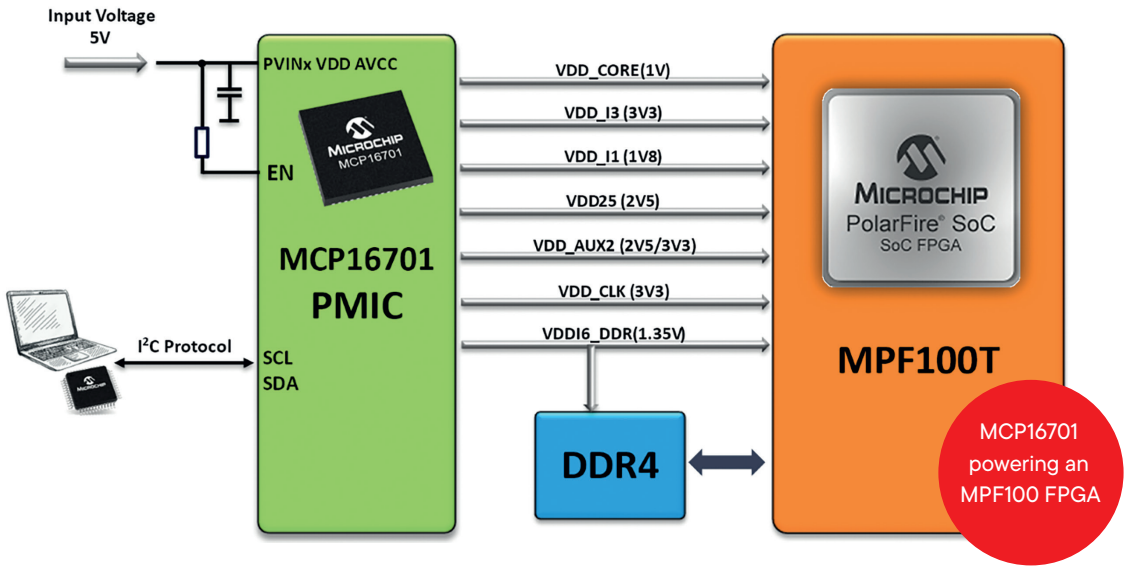
Highly integrated PMICs offer key advantages



The power management solution of choice for AI and industrial automation

by **John Demiray,** senior product marketing manager at **Microchip Technology's analog power and interface division**

Power Management Integrated Circuits (PMICs) are specialized electronic components designed to manage the power requirements of various systems and devices. These integrated circuits are essential in modern electronics, providing efficient power conversion, distribution, and management to ensure optimal performance and longevity of electronic devices. PMICs are widely used in a range of applications, from portable devices like smartphones and tablets to complex systems in data centers and industrial equipment.



One of the significant advantages of PMICs is their ability to provide multiple outputs. This feature is crucial for complex systems that require different voltage levels for various components. A PMIC device can simultaneously supply power to the core processor, memory, and peripheral devices, each with specific voltage requirements. This capability simplifies the power design, reduces the number of external components needed, and enhances the overall efficiency of the power management system.

Using a PMIC can optimize the design layout without sacrificing efficiency or thermal performance. Whether it's a configurable or scalable solution, PMICs are highly integrated and efficient devices, reducing system complexities while using fewer components. High-density PMICs are ideal for powering high-current digital loads, such as FPGAs and processors.

Microchip recently introduced the MCP16701 and MP164GX1000 PMICs, designed for powering high-performance and high-accuracy FPGA and MPU applications. Both PMICs integrate eight 1.5A buck converters that can be paralleled, four 300mA internal Low Dropout Voltage Regulators (LDOs), and a controller to drive external MOSFETs, resulting in a 48% area reduction with less than 60% of the component count of a discrete solution.

A key feature of both PMICs is their ability to dynamically adjust V_{OUT} levels for all converters in 12.5mV/25mV increments, allowing for fine-tuning of power to optimize overall system efficiency and performance.

Another important feature of PMICs is the accuracy of the V_{OUT}, especially in the case of sensors and advanced MPU geometries that require < ±1% across the temperature range of operation. Start-up and shut-down sequencing of different V_{OUT} levels is also key.

Both PMICs are available in a small-form-factor 8mm × 8mm VQFN package, offering a compact and flexible power management solution for space-constrained applications.

Conclusion

PMICs are the power management solution of the future for today's evolving applications, such as AI and industrial automation. Their ability to integrate multiple functions—power converters, LDOs, and communication interfaces—enhances overall efficiency, reduces board space and component count, and improves design and performance. As technology continues to advance, the role of PMICs in ensuring the optimal performance and longevity of electronic systems will only become more critical.

www.microchip.com



Soaring beyond copper

Advanced materials are building a greener future for aerospace wiring systems

by **Jeff Wood,** Sales Director at **WireMasters**

Keeping up with sustainability efforts across the aviation industry is a challenging task. However, reducing environmental impact while maintaining high safety and performance standards is an industry imperative. Aircraft wiring is no exception to this, and manufacturers have begun to implement innovative weight-saving materials, such as aluminium alloy conductors, carbon fibre composites, or polytetrafluoroethylene (PTFE) jacketing, in airborne cable systems.

Weight reduction is a crucial factor in enhancing fuel efficiency and lowering emissions. For each kilogram (kg) of weight reduced, an aircraft saves approximately 0.03kg of fuel per 1,000 kilometres (km), which translates to a saving of around 0.0945 kg of carbon dioxide (CO_2) emissions per 1,000 km. Considering this, even the smallest weight change in wiring systems can make a difference.

Distributors play a key role in managing these challenges by collaborating closely with aerospace manufacturers. Broad inventories of advanced, compliant materials and technical support enable aerospace manufacturers to reap the sustainable benefits of a lighter cable system without compromising on safety and performance.

Advanced materials

Traditionally, aerospace cabling has relied on copper thanks to its excellent conductivity. However, its density significantly contributes to an aircraft's weight, prompting the industry to explore alternative materials without compromising performance.

Aluminium (Al) alloy conductors have infiltrated the market as a popular alternative to copper. Usually comprised of aluminium, copper, iron, and magnesium, each metal's individual properties contribute to the conductor's resistance, creep resistance, and strength.

While Al alloys don't quite match copper's conductivity, they offer up to 50% weight reduction in wiring applications with the equivalent electrical resistance. This balance of conductivity and weight makes them suitable for avionic systems, improving fuel efficiency, which aligns with the industry's sustainability goals.

Longevity also plays a role in the aerospace industry's greener future. Longer equipment lifespans not only save businesses money on maintenance costs but also reduce the need to fully replace old systems. This minimizes electronic waste and reduces the need for frequent raw material extraction, which results in lower carbon emissions.

Similarly, composite PTFE jackets in aerospace wiring enable increased durability and resistance, which are crucial for longer operational lifespans, while reducing footprint and weight.

PTFE jackets offer superior abrasion resistance, chemical resistance, and operational performance in temperatures up to 260°C. This increased durability enables cables to have a service lifespan of up to 30 years, minimizing the need for regular replacement and waste. These jackets also meet the stringent aerospace industry standard AS22759, which ensures insulator performance and quality.

Fibre optic cables are another advancement focusing on both performance and quality. They are lighter than metal-core cables, typically weighing approximately 4 pounds per 1,000 feet, whereas copper cable weighs around 39 pounds per 1,000 feet. Fiber also offers higher bandwidth, supporting transfer speeds of up to 10 Gigabits per second (Gbps) and immunity to electromagnetic interference (EMI).

In aerospace applications, fibre's improved signal integrity reduces the need for heavy shielding and simplifies cable design. This enables a substantial reduction in an aircraft's weight, which enhances fuel efficiency without compromising performance or reliability.

Supplying sustainability

Adopting sustainable, high-performance cabling that also meets industry standards is a process accelerated by supply chain partners like WireMasters. We can provide access to advanced materials in high demand, such as composites based on AS22759 standards and high-temperature, halogen-free insulation materials. We also provide technical expertise aligned with the most up-to-date standards and regulations, such as the Restriction of Hazardous Substances (RoHS) or FAR 25 Appendix F, to ensure these materials are used appropriately.

Working closely with OEMs, we can ensure a seamless transition to a sustainable aviation future driven by advanced materials. Supply chain coordination, including forecasting, inventory planning, and demand visibility tools, facilitates this transition, resulting in lighter, more efficient, and durable aircraft wiring systems. The result is more sustainable aircraft cable systems with extended maintenance cycles that contribute to reduced emission goals, such as Jet Zero.

www.wiremasters.com

The key to smarter, safer access control



The future of access control isn't just wireless—it's Wi-Fi HaLow

by **Michael De Nil,** CEO and Co-Founder at **Morse Micro**

In today's evolving landscape of smart buildings, modern access control systems are no longer optional; they are foundational. While the vision for intelligent access control is clear—secure, scalable, low-power, and easy to maintain—the underlying wireless connectivity options have traditionally fallen short of expectations… until now.

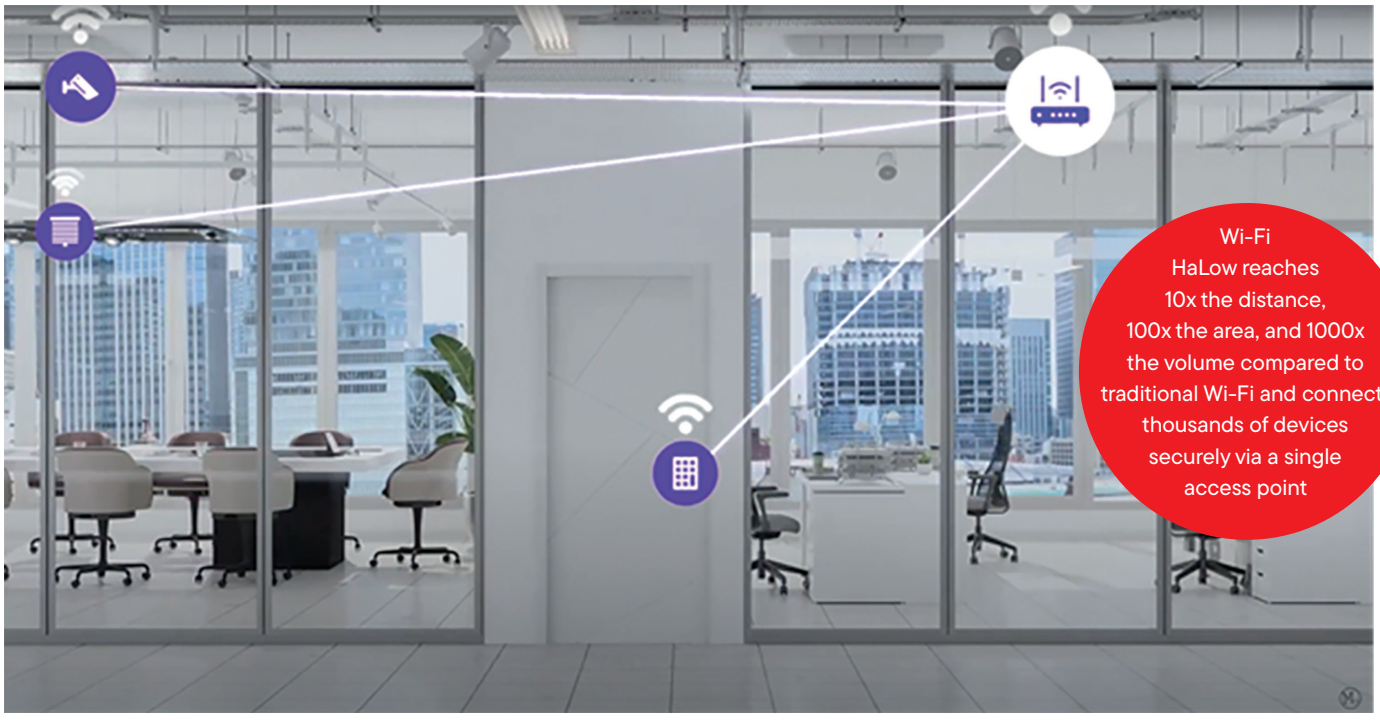
Wi-Fi HaLow, based on the IEEE 802.11ah standard, is poised to redefine how engineers and system architects design access control networks for commercial buildings, campuses, and industrial facilities. Offering an unbeatable combination of long range, low power consumption, robust security, and massive scalability, Wi-Fi HaLow is setting a new benchmark for next-generation access systems.

Historically, access control systems have relied heavily on wired infrastructure, such as RS-485 or Power-over-Ethernet (PoE). While reliable, these wired networks present multiple challenges:

- **Cost and complexity:** Running cables through walls, floors, and ceilings is labor-intensive, expensive, and disruptive to existing structures.
- **Scalability limitations:** Adding new doors, gates, or credential readers often requires costly rewiring or installing additional intermediary gateways.
- **Design inflexibility:** Once installed, wired systems are difficult and expensive to reconfigure or upgrade to support evolving needs.

Wireless alternatives based on traditional Wi-Fi, Bluetooth, or proprietary protocols introduce their own problems, ranging from insufficient range and poor penetration to unreliable performance and limited device density.

What designers and engineers need is a solution that combines the reliability of wired systems with the flexibility and cost-efficiency of wireless technology, all without compromising security or scalability.



Wi-Fi HaLow operates in the sub-GHz frequency band (typically 902–928 MHz), giving it several technical advantages over traditional Wi-Fi (2.4 GHz, 5 GHz) and other short-range wireless options:

- **Superior range and penetration:** Wi-Fi HaLow signals travel 10x farther than 2.4 GHz Wi-Fi and penetrate walls, floors, and industrial materials more effectively.

- **Ultra-low power consumption:** Ideal for battery-operated smart locks, credential readers, and occupancy sensors, Wi-Fi HaLow dramatically extends device battery life, reducing maintenance overhead.

- **Massive device capacity:** A single Wi-Fi HaLow access point can securely connect thousands of devices, perfect for large-scale commercial deployments.

- **Native IP connectivity:** Unlike proprietary or mesh protocols, Wi-Fi HaLow devices communicate directly over IP networks, simplifying integration with cloud platforms, mobile apps, and enterprise systems.

- **Strong security:** Wi-Fi HaLow incorporates WPA3 encryption, which ensures secure, session-based communications across the network.

By addressing these critical technical challenges, Wi-Fi HaLow enables engineers to design access control networks that are truly scalable, resilient, and future-ready.

Imagine designing a new multi-building campus. Traditionally, each building would require extensive wiring for access control doors, security sensors, and credential readers. Any future network upgrades would necessitate pulling additional PoE cabling or extending RS-485 bus segments, making for expensive and time-consuming projects.

With Wi-Fi HaLow, system architects can deploy a simplified, star-based network topology. A single Wi-Fi HaLow access point on each floor, connected via an existing Ethernet or fiber backbone, can wirelessly support hundreds of battery-powered locks, keypads, motion sensors, and cameras. No need for intermediary gateways. No proprietary mesh hubs. No costly wiring or rewiring.

Smart locks equipped with Wi-Fi HaLow can authenticate users, receive credential updates, and even support multi-factor authentication (MFA) systems—all while running on battery power for up to a year. Even if doors are located deep inside buildings, Wi-Fi HaLow's superior penetration ensures reliable connectivity without the need for signal extenders or repeaters.

And it's not limited to doors: Wi-Fi HaLow-enabled vehicle gates, barrier arms, and perimeter security systems all benefit from the same long-range, low-power advantages, eliminating the need for trenching cables across parking lots or outdoor spaces.

Future-proofing for evolving smart building needs

The evolution of smart buildings will be driven by trends such as touchless access, AI-powered surveillance, and integrated energy management. Connectivity solutions must adapt to these and future trends. Wi-Fi HaLow provides a flexible, future-proof foundation:

- **Supports evolving** encryption and credential standards through firmware updates over the air (OTA).

- **Accommodates additional** device types like occupancy sensors, indoor air quality monitors, and asset tracking beacons without requiring new infrastructure.

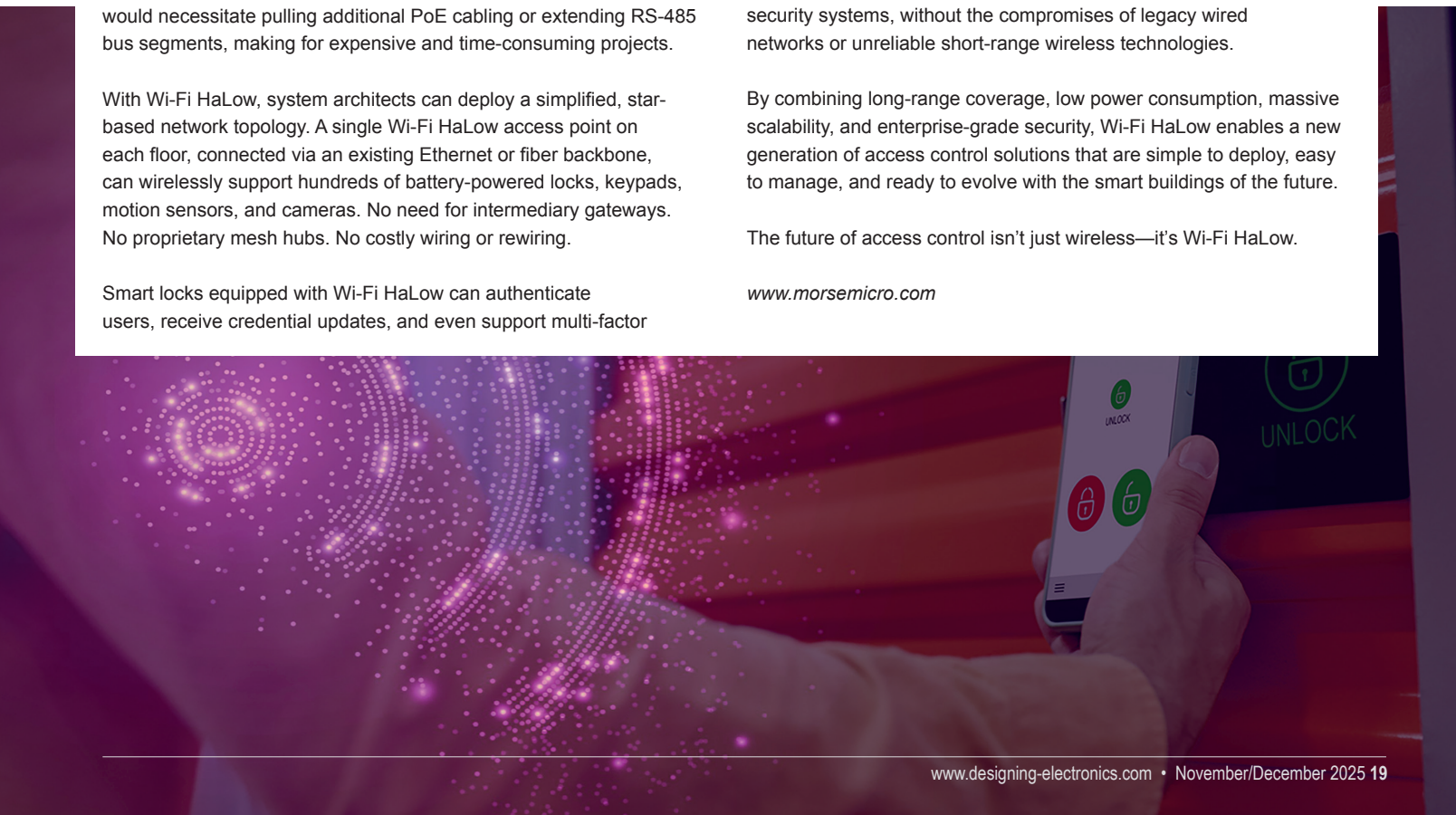
- **Enables hybrid** cloud/on-premise architectures, allowing facilities to balance security and scalability based on their unique operational needs.

In short, Wi-Fi HaLow ensures that access control systems not only meet today's requirements but are also ready to seamlessly adapt to tomorrow's innovations. The traditional barriers to creating secure, scalable, cost-effective access control systems are falling away. Wi-Fi HaLow offers engineers a powerful new tool for designing more intelligent and resilient building security systems, without the compromises of legacy wired networks or unreliable short-range wireless technologies.

By combining long-range coverage, low power consumption, massive scalability, and enterprise-grade security, Wi-Fi HaLow enables a new generation of access control solutions that are simple to deploy, easy to manage, and ready to evolve with the smart buildings of the future.

The future of access control isn't just wireless—it's Wi-Fi HaLow.

www.morsemicro.com

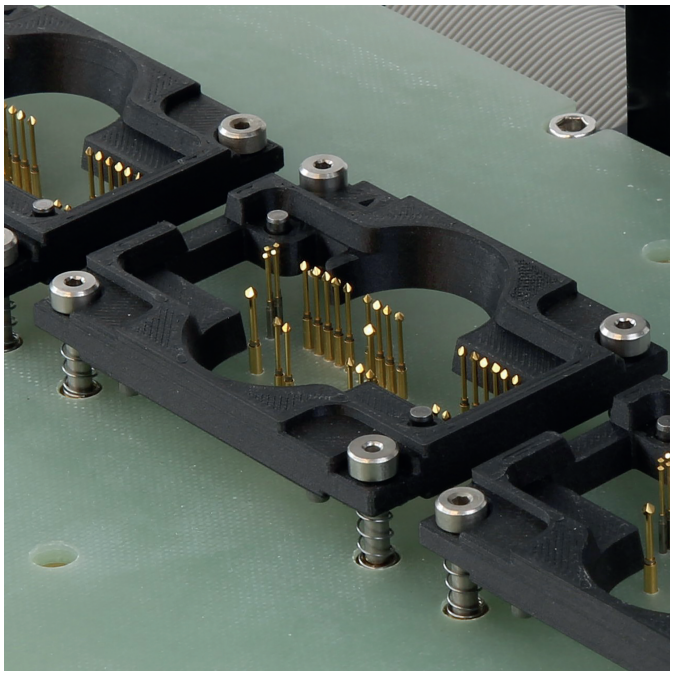


The next generation of test fixtures

Developing functional test fixtures to match modern product technologies

by **Jone Lay,** MSEE, Chief Technology Officer **at Boulder Engineering Studio**

While the benefits and capabilities of microelectronics design have increased exponentially in the last 20 years, electronics manufacturing testing approaches have struggled to keep pace, creating significant challenges for production teams. As devices under test (DUTs) incorporate increasingly sophisticated functionality, traditional test fixture approaches are failing on three critical fronts: 1) Hardware reliability demands are escalating as test point densities increase and signal integrity requirements tighten 2) Software integration challenges multiply as engineers struggle to connect DUTs to external test hardware and external, often remote, systems, and 3) Modern products demand sophisticated data collection and reporting, capturing not only test results but also configuration parameters, environmental conditions, and process metrics, without which design engineers cannot rapidly address quality concerns or accommodate changing requirements.



Test fixtures must serve as the critical bridge, connecting traditional infrastructure to engineering and manufacturing oversight. Modern practices also demand reporting thorough, functional data, increased automation, and reduced cycle times- all while fitting existing footprints and protecting against obsolescence. These capabilities must also be delivered at per-product NRE levels within supply chain timelines, measured in weeks and at costs below that of historical methods.

These challenges are often viewed independently, but their siloing creates cascading problems throughout the development and deployment process. Ultimately, the accuracy of your testing results is only as good as your test fixture. A mechanically unreliable fixture creates software debugging nightmares that consume engineering resources and delay launch. Complex software architectures make operational deployment exponentially more difficult, requiring specialized expertise for routine tasks, even simple ones like changing voltage limits. Traditional piecemeal solutions that address individual aspects while ignoring the interconnected nature of these problems inevitably fall short, creating costly integration challenges, performance compromises, and closed proprietary ecosystems. The industry needs a comprehensive platform approach that simultaneously addresses hardware reliability, software scalability, and operational efficiency through integrated engineering disciplines.

Elements of the eLink programming and test fixture platform

The eLink platform exemplifies a complete, modular solution combining sophisticated, but accessible software architecture with robust mechanical and electrical design. Featuring easily replaceable parts minimizes downtime, and supports drop-in design updates rather than requiring completely new fixtures for variants, revisions, and generational DUT changes. Unlike traditional fixture approaches that treat these elements as separate concerns, eLink's holistic system approach creates a cohesive solution addressing the full spectrum of automated test challenges.

Traditional test fixtures struggle with the fundamental challenges of accessing increasingly dense test points while maintaining signal integrity and mechanical reliability throughout production. Modern manufacturing demands precise electrical interfaces and robust mechanical systems that can withstand extended production use while ensuring operator safety and measurement accuracy. eLink's mechanical interface delivers 250,000+ cycle maintenance intervals with consumable components replaceable in minutes to minimize line downtime. Standard components are available through general suppliers like Digikey, avoiding single-source dependencies. The modular assembly allows quick component replacement when needed, with hinged access providing easy reach to test and interface modules.

The electrical architecture features carrier boards accommodating DUT-specific I/O modules and expandable parallel operation capability. USB, HDMI, and Ethernet connectivity allow for flexible test station and network configurations. The system handles ±100V DUT signals normally, with high voltage AC interface options available

and hardware interlocks to prevent unsafe operation. Onboard environmental sensors and interval counters confirm test conditions and ensure maintenance schedules. Additional off-board test equipment can be readily integrated with the eLink fixture as the central hub of a comprehensive test station.

Enterprise integration capabilities form the backbone of eLink's connectivity, connecting manufacturing test operations to broader business systems through easily definable ERP modules, comprehensive test result database connectivity, and barcode tracking systems that ensure complete traceability throughout the manufacturing process. This empowers design engineers with the advanced features and management they need, regardless of the CMs stage of technological implementation.

eLink's comprehensive monitoring and control capabilities transform manufacturing operations through browser-accessible dashboards that provide real-time visibility into fixture performance across production environments.

"Test fixtures must serve as the critical bridge, connecting traditional infrastructure to engineering and manufacturing oversight."

Local-only functions create many features, even within IT-limited networks. Operator-friendly UIs offer intuitive visual feedback and simple test parameters configuration without requiring specialized programming knowledge. Designing operator-accessible GUI controls for custom tests can be done with minimal additional code. User access control systems provide granular permissions and audit capabilities, effectively bridging engineering complexity with manufacturing usability.

The platform's development foundation relies on eLink's Python SDK, which provides hardware abstraction that automatically scales tests from single to multiple DUT scenarios without code modification. Simple changes can be managed by human readable configuration files, and more advanced developers can extend functionality by building on the Python backend. This à la carte feature mixing and low code volume requirements enable rapid customization to fit any workflow while dramatically reducing development time and complexity.

Design and manufacturing engineers stand at the intersection of traditional manufacturing and Industry 4.0 transformation, where test fixtures can either become bottlenecks or competitive advantages. eLink's comprehensive platform bridges this gap by integrating mechanical reliability, software scalability, and operational intelligence into a single cohesive solution.

www.boulderes.com



Why stealing automotive ECU firmware is surprisingly easy



Poor protection makes firmware extraction a growing risk for OEMs

by **Dr. Tim Blazytko,** Co-Founder and Chief Scientist at **Emproof**

An “Assist-Plus” box may appear harmless—a simple plug-in promising smoother driver assistance and a lighter touch on long commutes. Now imagine the following scenario. The box was, in fact, built by a maker who had purchased a spare steering ECU, disassembled it, removed the firmware, and reverse-engineered the bootloader. After identifying a weakness, they extracted the message-authentication keys the car uses to determine which components to trust and used them to build their own plug-in. This counterfeit device installs as an in-line module that the car accepts as native, speaking on the vehicle bus and sending cryptographically authenticated messages that appear genuine. Adoption spreads, and nothing signals tampering.

Weeks later, odd steering faults appear: low-speed curb strikes, occasional mid-corner jolts, issues no one can easily reproduce. Incidents multiply as more cars receive the device, and eventually, investigators connect the dots. The manufacturer suddenly owns a crisis it didn’t create, with safety recall notices to draft, service campaigns to run, fleet-wide software updates, scrutiny from regulators, and headlines about “factory trust in the wrong hands.”

While fictional, the mechanics are very real. In 2024, researchers extracted AUTOSAR SecOC keys from a 2021 Toyota RAV4 Prime steering controller by purchasing a spare rack, utilizing voltage fault injection to dump the firmware from a Renesas RH850/P1M-E, and then reverse-engineering both the application and the bootloader. Because the implementation lacked an HSM and left key material readable in memory, the researchers successfully executed code and built a payload to exfiltrate the keys over the vehicle’s network. With those keys, they could generate valid MACs and issue authenticated messages, demonstrating how third-party devices could be accepted as “native” on the bus.

Attacker incentives

Episodes rarely start with sabotage; they start with incentives. Firmware holds value, so attackers follow the money. Some focus on unlocking features to avoid paying for software-gated options. Others pursue piracy and device cloning, copying ECUs or calibration sets to sell as cheaper drop-ins. A third group hunts embedded secrets such as cryptographic keys, which allow hardware to impersonate trusted components or enable counterfeit parts. Around this sits a market for exploits and enablement tools, where one team performs the hard reverse engineering and many resellers package the results as ready-to-use kits or services.

For OEMs, the impact is tangible: lost revenue from bypassed paid features and cloned units, a growing counterfeit ecosystem, regulatory scrutiny, and rising warranty and service costs with every illicit install.

```
001013f6 55        PUSH    RBP
001013f7 48 89     MOV     RBP,RSP
         e5
001013fa 89 7d     MOV     dword ptr [RBP + local_1c],n
         ec
001013fd c7 45     MOV     dword ptr [RBP + a],0x0
         f0 00
         00 00 …
00101404 c7 45     MOV     dword ptr [RBP + local_14],0x1
         f4 01
         00 00 …
0010140b 8b 45     MOV     EAX,dword ptr [RBP + local_14]
         f4
0010140e 89 45     MOV     dword ptr [RBP + b],EAX
         f8
00101411 83 7d     CMP     dword ptr [RBP + local_1c],0x0
         ec 00
00101415 75 07     JNZ     LAB_0010141e
00101417 b8 00     MOV     EAX,0x0
         00 00
         00
0010141c eb 2f     JMP     LAB_0010144d

                   LAB_0010141e                    XREF[1]…00101415(j)
0010141e c7 45     MOV     dword ptr [RBP + i],0x2
         fc 02
         00 00 …
00101425 eb 1b     JMP     LAB_00101442

                   LAB_00101427                    XREF[1]…00101448(j)
00101427 8b 55     MOV     EDX,dword ptr [RBP + a]
         f0
0010142a 8b 45     MOV     EAX,dword ptr [RBP + local_14]
         f4
0010142d 01 d0     ADD     c,EDX
0010142f 89 45     MOV     dword ptr [RBP + b],c
         f8
00101432 8b 45     MOV     c,dword ptr [RBP + local_14]
         f4
00101435 89 45     MOV     dword ptr [RBP + a],c
```

```
1
2 int fib(uint n)
3
4 {
5   int c;
6   undefined4 a;
7   undefined4 b;
8   undefined4 i;
9
10  a = 0;
11  b = 1;
12  if (n == 0) {
13    b = 0;
14  }
15  else {
16    for (i = 2; i <= n; i = i + 1) {
17      c = b + a;
18      a = b;
19      b = c;
20    }
21  }
22  return b;
23 }
24
```

The open-source reverse engineering framework Ghidra shows the disassembled code **(left)** as well as the approximated high-level code **(right)**, revealing a Fibonacci function.

Attack process

Despite the damage attackers cause, the process isn't a dark art—it follows the same pattern. First, attackers obtain access to an ECU firmware image, via a leaked update or an overly permissive diagnostic routine, for example. Next, the reverse engineering begins. Using tools that render the binary as low-level code (assembly), they recover function boundaries and control flow, reconstruct data structures and interfaces, and decompile the code into pseudocode that approximates the original source. With that map in hand, they can quickly sweep likely hot spots such as cryptographic key use, protocol handlers, and update or boot logic, then test hypotheses in a controlled setup before deciding where to push next.

In practice, the barrier to reverse engineering is lower than many expect. Free and powerful open-source tools, such as Ghidra (released by the U.S. National Security Agency in 2019), can ingest raw firmware and present source-like views, including low-level assembly alongside decompiled pseudocode, cross-references between code components, and call graphs, as well as quick pivots into bootloader code, update handlers, and protocol endpoints. These features make large binaries navigable, allowing even newcomers to follow control and data flows to see how features are gated and where keys are used. The experience isn't identical to having the source, but it increasingly feels like reading and auditing it. Experienced attackers take things a step further, utilizing scripting, emulation, and instrumentation to automate and scale their work.

Countermeasures

At this point, it may be tempting to assume that familiar safeguards such as hardware readout protections, debug locks, secure boot, and HSMs close off this path. In practice, they are necessary but not sufficient. Readout protections and debug locks increase the effort to obtain an image, yet they can be bypassed by hardware attacks. Once a firmware image exists, they offer no barrier to analysis. Secure boot confirms integrity and origin but not confidentiality, so a legitimate, signed binary can still be copied and analyzed. HSMs confine keys and expose cryptographic services, but they do not prevent code analysis or runtime observation outside the HSM boundary. These safeguards add security value, but do not stop reverse-engineering-based attacks.

Anti-reverse-engineering techniques fall into two broad categories: passive and active. Passive measures rely on code obfuscation, which rewrites the program into a deliberately complex form, making control and data flow more challenging to follow, while maintaining unchanged functionality. When run through a decompiler, such code tends to produce incomplete or misleading pseudocode rather than a neat, recoverable output.

Active measures, such as anti-debug, anti-emulation, and anti-tamper, insert runtime guards into the firmware that examine their environment as they execute. When something looks suspicious, they refuse sensitive operations or fall back to a safe error path. Anti-debug checks for breakpoints, tracing hooks, or attached debuggers and will not run cleanly when any of these are present. Anti-emulation probes for signs of virtualized or instrumented execution and stops when it detects them. Anti-tamper verifies the integrity of critical code regions and reacts to unauthorized modifications. In practice, passive and active controls are deployed together, reinforcing each other and forming a more complete barrier to reverse engineering than either can provide alone. This combination significantly raises the bar, requiring more expertise and analysis time, and turns reverse-engineering attacks into costly campaigns.

Regulation and interplay

These techniques didn't originate in the automotive industry. They were refined in multimedia and gaming, where protecting code and keys has long been a routine practice. The same needs now apply to embedded systems, especially in cars. UN R155 explicitly flags the extraction of proprietary software and cryptographic keys, as well as manipulation of vehicle code and data, including changing identifiers, bypassing monitoring, falsifying mileage or speed data, and unauthorized changes to diagnostic routines.

These are exactly the outcomes that large-scale reverse engineering enables. This is why software-centric measures such as obfuscation, integrity checks, device binding, controlled diagnostics, and signed updates with anti-rollback are increasingly expected alongside secure boot and HSMs. They don't replace those foundations; they add the missing layer that makes these threats harder and more costly to achieve, making opportunistic cloning or feature unlocking a poor business strategy.

www.emproof.com

```
int fib_obfuscated(uint n)

{
  uint local_1c;
  uint local_18;
  uint local_14;
  uint local_10;
  int local_c;

  local_c = (((n & 5) * 2 + (n ^ 5)) - n) + -5;
  while( true ) {
    if (local_c == 3) {
      return ((local_14 & n) * 2 + (local_14 ^ n)) - n;
    }
    if (3 < local_c) break;
    if (local_c == 0) {
      local_1c = (((n & 0x17) * 2 + (n ^ 0x17)) - n) - 0x17;
      local_18 = ((n & 1) * 2 + (n ^ 1)) - n;
      local_14 = (((n & 0x539) * 2 + (n ^ 0x539)) - n) - 0x539;
      local_10 = ((n & 2) * 2 + (n ^ 2)) - n;
      if (n == 0) {
        local_c = 3;
      }
      else {
        local_c = ((n & 1) * 2 + (n ^ 1)) - n;
        local_14 = local_18;
      }
    }
    else {
      if (local_c != 1) break;
      if (n < local_10) {
        local_c = ((n & 3) * 2 + (n ^ 3)) - n;
      }
      else {
        local_14 = (local_1c & local_18) * 2 + (local_1c ^ local_18);
        local_1c = ((local_1c & local_18) * 2 + (local_1c ^ local_18)) - local_1c;
        local_18 = ((local_1c & local_14) * 2 + (local_1c ^ local_14)) - local_1c;
        local_10 = (local_10 & 1) * 2 + (local_10 ^ 1);
        local_c = ((local_1c & 1) * 2 + (local_1c ^ 1)) - local_1c;
      }
    }
  }
  return ((n & 0x4d2) * 2 + (n ^ 0x4d2)) - n;
}
```

Decompiler output of a slightly obfuscated Fibonacci implementation. Due to the obfuscation, the code's purpose is not immediately clear.

Automation comes to analog verification

The verification of analog chips can now employ DFT and ATPG

Recently, a new capability has become available for verifying the analog mixed-signal (AMS) portions of sophisticated integrated circuits (IC), such as ASICs and System-on-Chip (SoC) devices. The biggest barrier to the adoption of this new technology is that most analog engineers are unfamiliar with the underlying concepts, such as fault simulation, design for test (DFT), and automatic test pattern generation (ATPG).

To set the scene, the first widely known and adopted analog simulator was SPICE, which was introduced in 1973. This spawned many commercial derivatives (HSPICE, PSPICE, Eldo, Spectre). The 1970s also saw the emergence of the first event-driven digital simulators, including LASAR, TEGAS, and HILO.

The digital domain experienced dramatic progress in what would come to be known as Electronic Design Automation (EDA), especially in the context of IC design and verification. Digital circuits are subject to drive faults on gate outputs (driving hard 0 or 1 values), stuck-at faults on wires (short circuits to ground or power), and open faults on gate inputs. Digital fault simulators were developed to apply these faults to virtual circuits to determine if test waveforms could detect them. Later, fault simulators were used in conjunction with ATPG to automatically (and quickly) generate test waveforms that provided high test coverage.

Many other digital DFT and verification techniques were developed, such as built-in self-test (BIST) for logic and memory. ASICs and SoCs can contain millions of flip-flops (register elements). In the 1980s and 1990s, scan technologies were developed in which all of the regular flip-flops in the chip were converted into scan flip-flops, which have an additional scan data input and mode control (the regular output doubles up as a scan data output). This allows all the registers in the chip to be viewed as a single, enormous shift register, enabling values to be shifted in and out of the chip's internals. When coupled with ATPG, this allowed for the rapid and automatic creation of sophisticated, high-coverage structural test waveforms. (In this context, structural test means verifying the integrity of the hardware's structure using scan chains, ATPG patterns, and fault models such as stuck-at faults.)

Although there have been advances on the analog side of the fence, it's widely acknowledged that analog DFT and test automation have lagged behind developments in the digital domain for decades. Until now, for example, it hasn't been feasible to implement a structural test strategy for the analog portions of the chip. Instead, analog tests have been predominantly functional in nature. That is, applying real-world input stimuli and measuring gain, offset, bandwidth, linearity, distortion, signal-to-noise ratio (SNR), and other parameters. Such functional tests require precision instrumentation, they

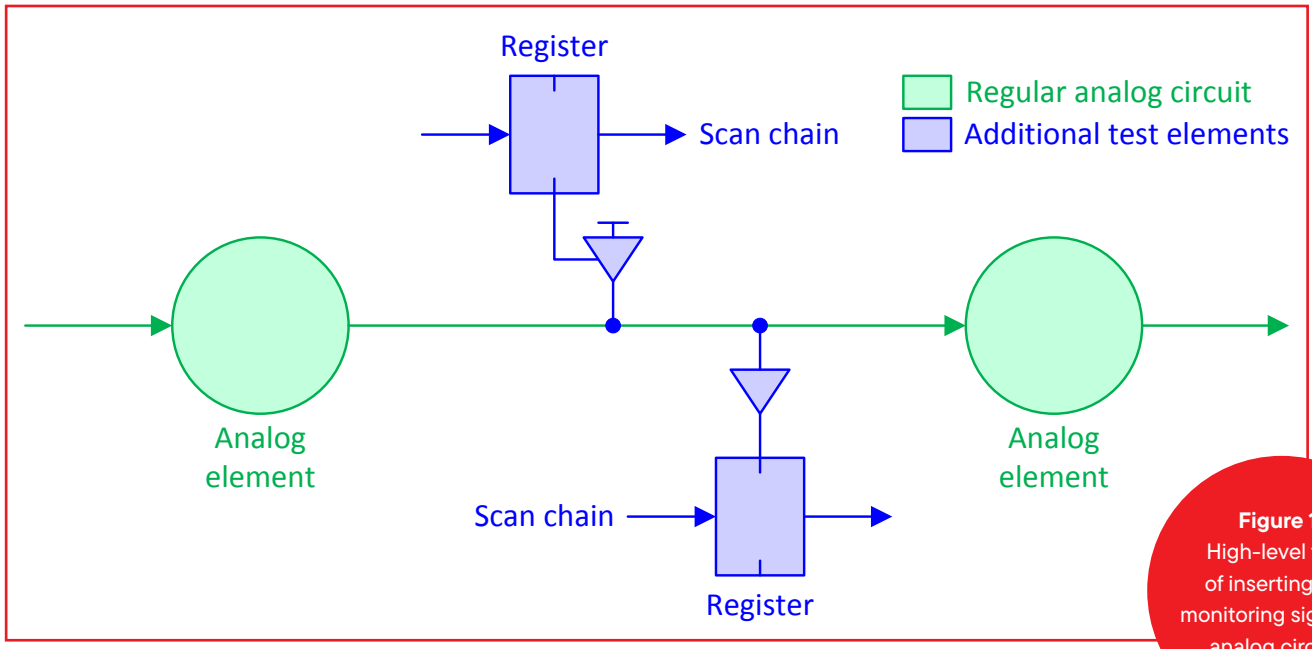


Figure 1: High-level view of inserting and monitoring signals in analog circuits

can be slow and expensive, and they may miss subtle defects.

All of this just changed. Tessent is a suite of tools and embedded logic IP from Siemens. This suite embraces analog, digital, and mixed-signal IC test, diagnosis, reliability, safety, security, and embedded analytics.

Tessent DefectSim is a transistor-level defect simulator for AMS circuits. This tool injects defects (faults) into transistor-level nets/circuit blocks, simulates whether those defects are caught by existing test patterns, and provides metrics like defect coverage and defect tolerance.

Recently, Siemens introduced Tessent AnalogTest. This tool automates the development of AMS test infrastructure (DFT) and test patterns (ATPG).

A high-level view of the way in which this works, as depicted in Figure 1, can be summarized as follows. Regular analog circuit elements (e.g., transistors) are shown in green. Additional test elements are shown in blue.

First, the circuit is placed into a static (unchanging) state. Observe the blue buffer driving a signal onto the analog wire. Based on the 0 or 1 value in its associated scan chain register, this buffer can drive a tristate value (which essentially disconnects it from the wire) or a specific voltage value that overdrives the regular analog element. Now observe the buffer monitoring the signal on the analog wire. This can be configured to generate a 0 or 1 based on a specific voltage threshold, and the resulting digital value can be loaded into the associated scan chain register.

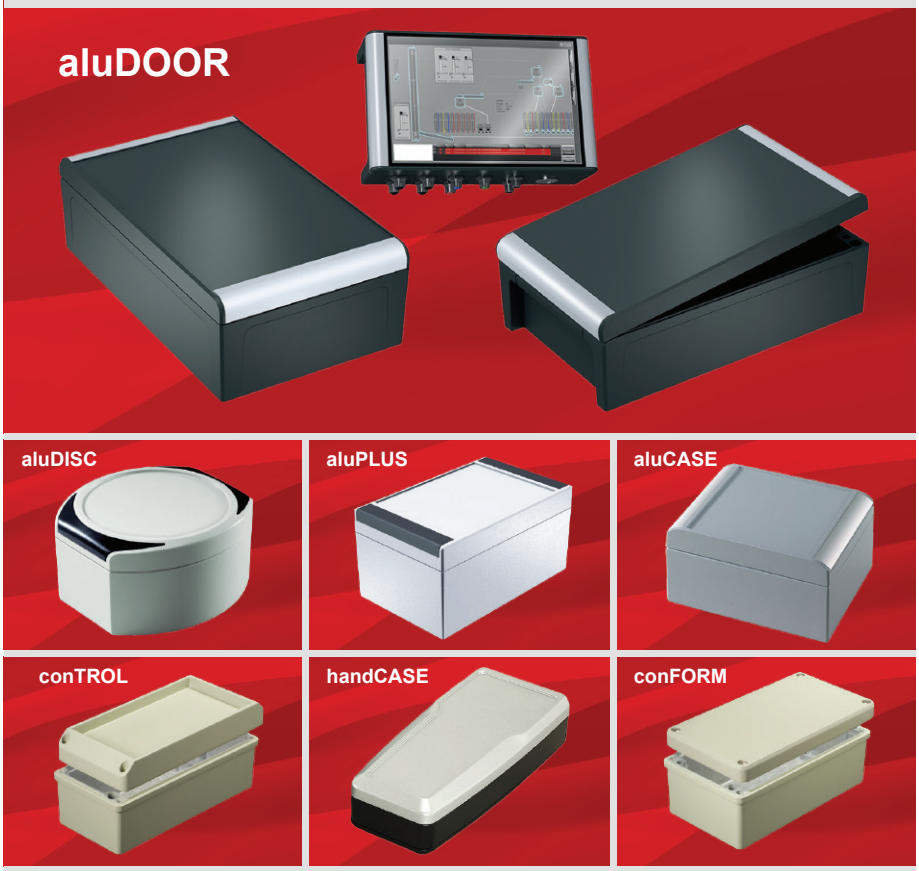
In some cases, it may be necessary to use multiple instances of these test structures to drive and monitor different voltage levels on the same wire. Having said this, it may also be that only a relatively small number of the analog wires require test structures to drive and/or monitor signals. The number, type, and placement of these test structures are automatically determined by Tessent AnalogTest, working in conjunction with Tessent DefectSim. In addition to generating these DFT structures, this dynamic duo can also provide the ATPG functionality to create the high-coverage tests.

As one example of this new technology, a traditional analog functional test that took ~20ms to provide a relatively low level of defect coverage was replaced by a digitally implemented analog structural test that took only 76µs to achieve a significantly higher defect coverage. Furthermore, this structural test was created automatically, thereby saving vast amounts of verification engineering time and resources.

What SPICE did for circuit simulation half a century ago, Tessent AnalogTest now promises to do for analog mixed-signal verification. The future of analog test may have just shifted under our feet.

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Electronic Enclosures: AI Will Help Designers Cut Costs



Rob Macek, *Sales Manager at* **OKW Enclosures, Inc.**

Artificial intelligence will streamline the enclosure specification process in more ways than you might expect, forecasts OKW Enclosures, Inc. Sales Manager Rob Macek.

Large Language Models (LLMs) can save time and money throughout the design process, including automated interpretation of documents/prompts, creating a library of variants, generative design, real-time checking, simulations, accelerated estimation, and the automated generation of drawings and documentation.

However, AI will also help inspire something more fundamental—a change in mindset when it comes to specifying enclosures, said Mr. Macek.

"AI will speed up the design of PCB layouts, and that in turn will inspire more designers to think 'enclosure first'."

"If designers know they can easily create or adapt a PCB layout to fit an enclosure, then they'll be more likely to consider the housing before they've finalized the board design."

"This matters because by thinking 'enclosure first', you can often specify a smaller housing, and this can reduce costs significantly," he added.

Regardless of the rise of AI, there will always be a place for the human touch: "When you phone OKW, you don't get an Interactive Voice Response (IVR) system—you go straight through to a real person who's ready and able to help you."

As if to prove the point, OKW is recruiting more Product Specialists to help meet growing demand for its enclosures and potentiometer tuning knobs.

www.okwenclosures.com

Turning challenge into opportunity



Mark Burr-Lonnon, *President at* **EDAC**

I predict a strong connector market in 2026; however, with many potential challenges. Price volatility due to minerals, especially gold, continuing global conflicts, ongoing worldwide tariffs, staffing challenges, a new allocation cycle, and emerging upsides and risks such as AI use/misuse and continual cyber threats. As Dutch football legend Johan Cruyff observed, "every disadvantage has its advantage." That mindset shapes our approach: we treat challenges not as barriers but as catalysts for innovation, adaptation, and stronger customer partnerships.

Inflationary pressures and raw material fluctuations, for example, drive us to re-engineer designs for efficiency, helping customers achieve cost savings without sacrificing reliability. Staffing constraints push us to invest in automation and training, improving responsiveness and consistency. Allocation risks, while disruptive, foster deeper collaboration with clients, giving us the opportunity to forecast earlier and secure capacity. Even global instability and its risks to the supply chain accelerate our commitment to expanding manufacturing capacity across the globe and diversifying regional impact.

At the EDAC Group of Companies, resilience is built into our structure. Our global footprint across provides supply continuity. Our multi-brand portfolio, EDAC, NorComp, MH Connectors, and Northern Technologies offers flexible options across price, performance, and application needs. Most importantly, our engineering-driven customization turns uncertainty into opportunity, delivering connector solutions designed not only for function but also for long-term availability.

We look forward to a good 2026.

www.edac.net

Collaboration Builds Continuity



Andrew Dixon,** Sales & Marketing Manager Americas, **Diotec Semiconductor

Supply chain resilience is now a key indicator of a business's strength – the capacity to predict, endure, and bounce back from disruptions. Resilience is not a single solution, but rather an ecosystem of technologies, partnerships, and strategies that ensure continuity. True resilience combines proactive risk management with agile recovery, allowing firms to adapt to shocks such as natural disasters, geopolitical tensions, and demand volatility.

Visibility is the foundation of supply chain resilience: real-time data across suppliers, manufacturing, logistics, and inventory improves forecasting and risk assessment. Diversified sourcing, dual suppliers for key components, and regionalized production reduce single points of failure. Diotec Semiconductor exemplifies this approach, with offices in the U.S., headquarters and chipfab in Germany, another chipfab in Slovenia and assembly sites in Slovenia and India, enhancing flexibility and reliability.

Collaboration is equally vital. Strong supplier relationships, clear contracts, and shared contingency plans support fast, coordinated responses. Transparent communication with customers fosters trust and stabilizes demand during times of uncertainty. Suppliers like Diotec Semiconductor strengthen resilience by providing dependable, reliable discrete components that help original equipment manufacturers (OEMs) sustain production despite market pressures.

As we look ahead to 2026, supply chains will become smarter and more adaptive through the use of AI, automation, regionalization, and risk analytics. However, vulnerabilities will persist in the form of geopolitical instability, cybersecurity threats, and energy volatility. Success will depend on balancing cost efficiency with robustness, embedding sustainability, and cultivating flexible, digitally connected networks. Companies that prioritize visibility, diversification, and collaboration over lowest-cost efficiency will have a competitive advantage.

www.diotec.com

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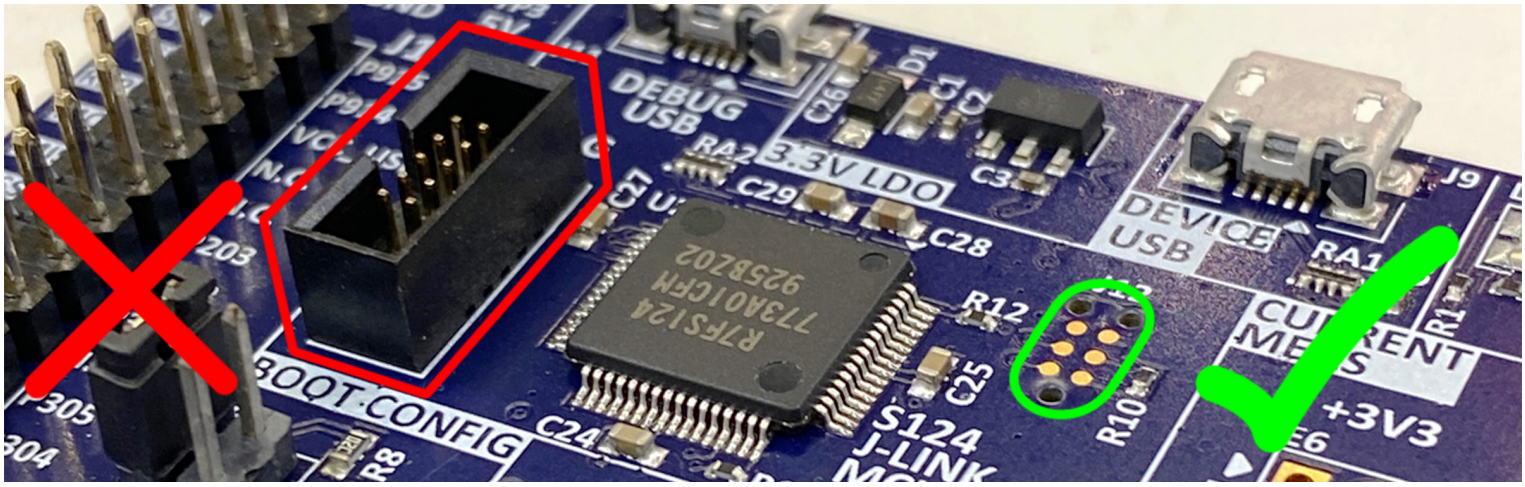
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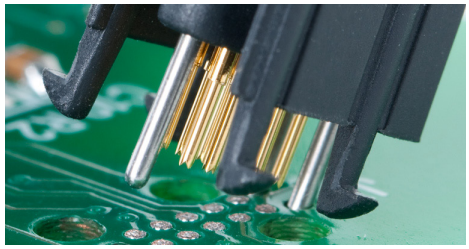
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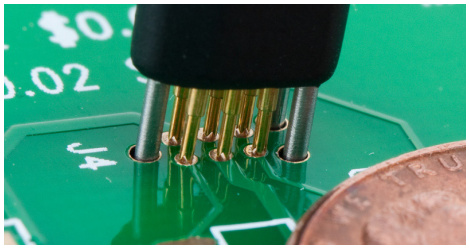


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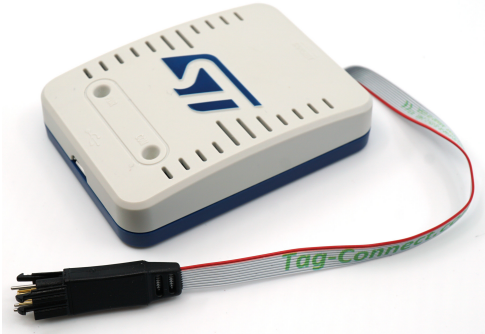


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