POWER ELECTRONICS EUROPE

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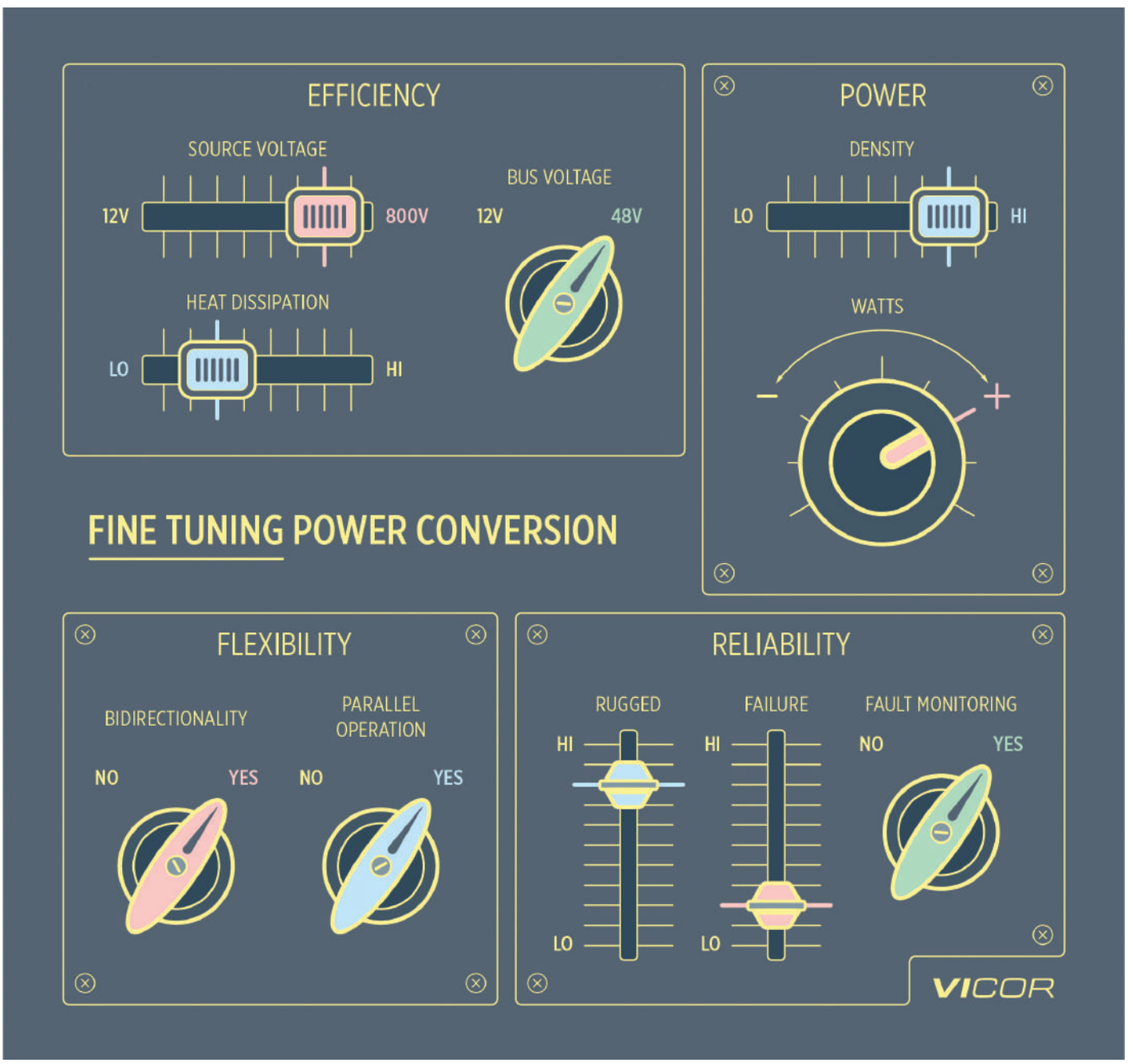
HIGH-VOLTAGE-TO-48V POWER CONVERSION

11 ways to fine tune your high-voltage-to-48V power conversion



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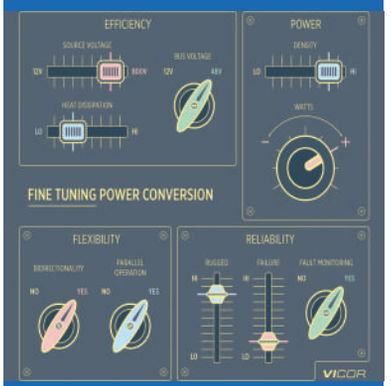
FEATURE STORY



11 ways to fine tune your high-voltage-to-48V power conversion

By Maury Wood, VP Strategic Marketing at Vicor

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New record for European renewables in Q1 2026

Power generation from renewables reached a new record across Europe in the first quarter of this year. That was the key takeaway from energy intelligence provider Montel EnAppSys' Q1 European Electricity Market Summary.

Total renewable generation across the quarter totalled 384.9TWh, thanks to record solar generation, a recovery in wind generation and strong hydro power production. This also helped to mitigate the impacts of the Iranian conflict on wholesale power prices, as strong renewable production displaced gas-fired generation, lessening the effect of the price spikes observed in gas markets across the quarter.

Solar outturn continued its steady climb, with capacity growth causing the quarterly generation total of 52.6TWh to be the highest solar outturn for any Q1 on record, 15% above the same period last year. The biggest contributor to the overall figure was wind, generating 173.7TWh across the quarter, a 22% rise on Q1 2025. Hydro totalled 128.6TWh, making a strong recovery from Q3 2025, during which low levels of rainfall caused hydro output to slump to 97.1TWh. By contrast, this winter has seen unusually high levels of rainfall, allowing for a replenishment of reservoirs and for hydro output to return to more usual levels.

Despite being the highest quarterly total on record, the proportion of generation that came from renewables remained at 48.8%, below the equivalent percentage seen in previous quarters.

This can be explained by cold weather conditions, which raised demand to the highest level seen since 2022. With Central and Eastern Europe most impacted, January saw temperatures 1-4°C colder than average, driving up total demand across the quarter to 829.3TWh, an increase of 1.4% versus the same period in 2025.

Speaking about the report's findings, Director at Montel EnAppSys, Jean-Paul Harreman said: "Weather will determine if further renewable records are broken, but continued solar growth is likely. Solar outturn for Q1 was high given the lack of daylight at this time of year; this shows that the capacity of solar across Europe continues to grow and will likely deliver huge volumes of electricity in the summer, which can be expected to exceed last year's record breaking solar generation figures.

"Demand is set to decline in Q2 as warmer temperatures arrive, but heatwaves could yet stress the European energy system. Should heatwaves come to pass in late Q2, or even a 'Super El Niño', as has been described by some observers, this could create a lot of stress on the system at a time in which stocks of gas are not only low, but more expensive to replenish as uncertainty around the Iranian conflict continues."

Q2 outlook

The report also states that Q2 2026 is expected to be characterised by periods of massive surplus renewable generation, resulting in negative prices across Europe. This will also lead to the commercial curtailment of renewables and nuclear modulation during solar peak and high wind periods at nights and weekends.

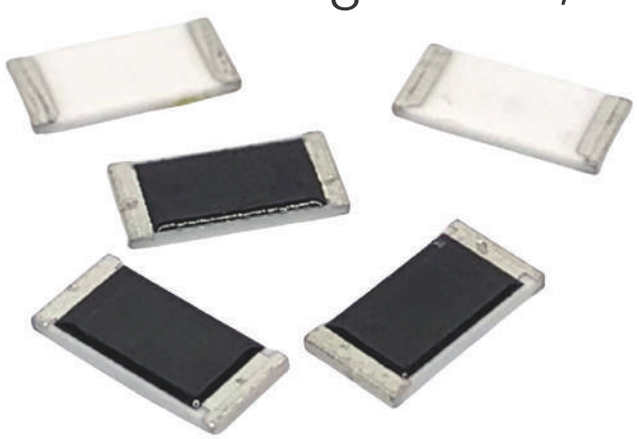
This will also lead to relatively high evening peak prices, driven by gas prices as renewables drop after solar peak and peaking plant comes online to meet demand.

Together, these dynamics paint a complex picture: one in which record-low prices and record-high evening peaks may co-exist, underscoring the structural challenges facing Europe's transition-era electricity system.

Download the full report: Montel European electricity market summary Q1 2026.pdf

https://montel.energy/about-us

Stackpole Expands RMAN Aluminum Nitride Chip Resistors for High Power, Thermally Constrained Designs



Rising power density in modern electronics is pushing traditional thick film chip resistors beyond their thermal limits. In applications where high-power dissipation, electrical isolation, and long-term stability must coexist, aluminum nitride (AlN)–based thick film chip resistors are becoming the preferred solution.

Stackpole Electronics says its RMAN series utilises aluminum nitride substrates with thermal conductivity several times higher than standard alumina, enabling faster heat removal while maintaining electrical insulation. This allows higher usable power density, lower operating temperature, and improved stability in demanding environments.

RMAN resistors are purpose-designed for applications where thermal performance directly affects electrical behaviour and reliability. Typical uses include snubber and gate resistors in IGBT, SiC, and GaN power modules; pre-charge and discharge circuits in industrial and EV drives; and current sensing

and bleeder functions in power supplies and inverters.

The series is also well suited for automotive electronics such as battery management systems, onboard chargers, DCDC converters, and inverter gate drives, where thermal cycling and continuous load demand stable resistance characteristics. In RF and microwave circuits, RMAN devices support terminations, attenuators, and dummy loads by maintaining impedance stability under high dissipation. Additional applications include high-power LED and laser drivers, aerospace and defence power conditioning, and high-voltage divider networks where temperature gradients can degrade accuracy.

RMAN chip resistors deliver power ratings up to 2.4 W in 1206 and 3.4 W in 2512 packages while maintaining safe hotspot temperatures—performance difficult to achieve with alumina-based thick film designs.

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For more information about Stackpole's RMAN Series thick film high power aluminum nitride substrate chip resistors, visit https://www.seielect.com/catalog/SEI-RMAN.pdf

https://www.seielect.com/

Tria Technologies Launches Module with New Generation Intel Processor

Tria Technologies, an Avnet company specialising in the design and manufacture of embedded compute boards, systems and HMIs, has announced it has launched the new COM-HPC Client Computer-on-Modules (CoM) product, powered by the Intel Core Ultra Processors (Series 3).

Marking a significant milestone as Tria's first product to incorporate Intel's new-generation processors, the new module is purpose-built for demanding AI at the Edge applications in automation and robotics where high performance and ultimate reliability are critical. The multiple benefits include uncompromised AI performance, coupled with lightning-fast response times.

The new COM-HPC Client Size A module sets a new standard for embedded computing performance with up to sixteen cores and an integrated AI accelerator (NPU). This advanced platform supports up to 64GB of high-speed LPDDR5x SDRAM with IB-ECC for enhanced reliability, and harnesses Intel Xe graphics with up to 12 Xe cores for superior visual performance.

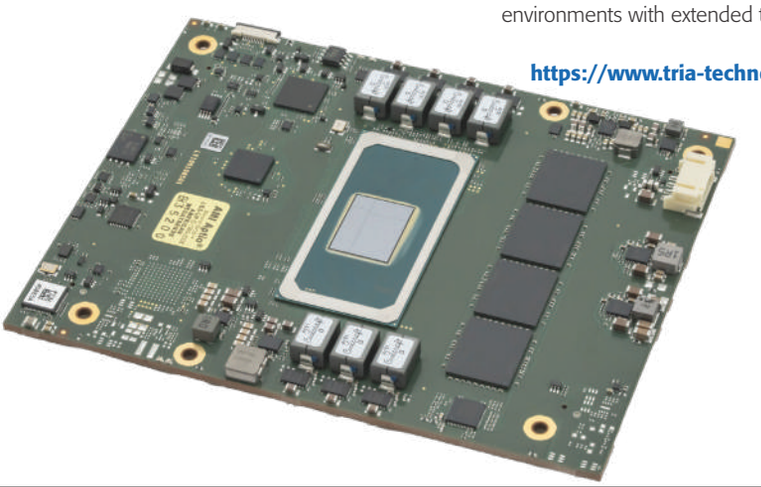
Developed for design engineers and system architects, the new module features a fully integrated AI accelerator (NPU). Alongside Intel Xe graphics with up to 12 Xe cores, it achieves industry-leading AI performance of up to 180 trillion operations per second (TOPS).

Tria's COM-HPC allows for compact and cost-efficient Edge solutions with no need for external PCIe based accelerators or cloud-based AI services. It also enables AI applications to run in a controlled environment and can act as a substitute for GfX accelerators in medical, spectroscopy, data analysis and gaming applications as well as automation and robotics applications, Tria Technology's Senior Director and Business Line Manager Daniel Denzler said, "This solution establishes a new benchmark for cutting-edge AI and Edge computing. Additionally, customers can rely on long-term availability, ensuring seamless integration and future-proof investment for mission-critical deployments."

Offering versatile display outputs, it supports four independent display streams available from different display interfaces including DisplayPort/HDMI, embedded DisplayPort and USB-C. For high-bandwidth I/O extensions system designers can utilise multiple PCI Express Gen 5 and Gen 4 lanes, a large variety of USB4, USB 3.2 and USB 2.0 ports, plus network and SATA storage options.

With Trusted Platform Module TPM 2.0 and a commitment to long-term product availability, this module is said to be an ideal choice for demanding applications requiring robust performance, security, and longevity. Furthermore, the product design allows the board to operate in environments with extended temperature ranges.

https://www.tria-technologies.com/



Smart, Easy To Use, Eco-Friendly: FX-250 Digital Fibre Sensor

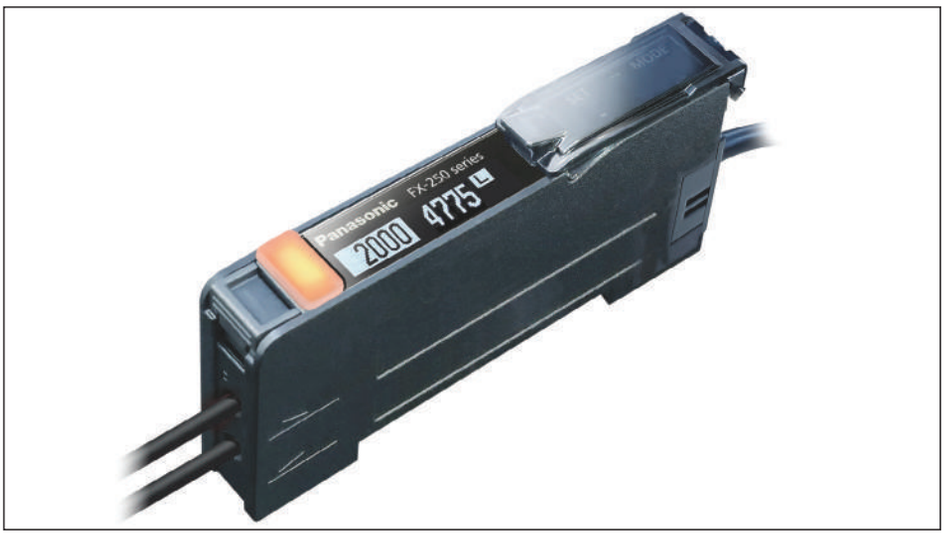
Panasonic Industry Europe has announced it is introducing the new FX250 digital fibre sensor designed to support users in their daily working routines as effectively as possible.

The FX-250 offers a large, highcontrast OLED display providing excellent readability and shows not only numerical values, but also fully written text. This makes menu navigation intuitive and significantly reduces the risk of operating errors, especially for less experienced users or teams working in shifts. As a result, settings can be checked and adjusted quickly even from a distance, helping reduce setup time and machine downtime.

A particularly practical feature is the new twostep limit teaching, which no longer requires manual adjustment of the emitted light. By simply pressing a button twice, the sensor reliably learns the switching threshold—even under challenging lighting conditions such as reflections or incident light saturation. This makes machine setup considerably faster and ensures stable detection of shiny, transparent, or very small components, providing reliable performance even in demanding industrial environments.

The FX250 also stands out with its extremely compact design. Its newly engineered cover requires an opening radius of only 30 millimetres, enabling installation in very restricted spaces and simplifying maintenance without the need to reposition surrounding components. This makes the sensor ideal for modern production machinery where space is limited and accessibility is crucial.

Energy efficiency has also been a central focus in the development of the FX250. Three integrated ECO modes automatically reduce energy consumption by dimming the display after a short period of inactivity or switching off the display and indicators entirely if required. This feature is particularly beneficial in 24/7 production environments with a large number of sensors installed, where even small savings contribute to substantial overall energy reductions and support



companies in achieving their sustainability goals.

With a response time of just 35 microseconds, the FX250 is also perfectly suited for applications requiring fast and precise detection. Even the smallest or rapidly moving objects are reliably identified, increasing process stability and reducing the risk of errors in highspeed production lines.

"With the FX250, we are expanding our fibre sensor portfolio with a highly userfriendly series that significantly simplifies everyday work in industrial automation," says Angelika Selzle, Head of Product & Business Management Sensors at Panasonic Industry. "We have engineered a very compact yet powerful digital fibre sensor. With its response time of 35 µs, it is ideally suited for requiring highthroughput performance."

http://industry.panasonic.eu

Infineon Wins "AI Impact Award 2026" for Delivering Measurable Business Value in Semiconductor Manufacturing

Infineon Technologies has announced it has been honoured with the AI Impact Award 2026 for its "GenAI for Test Engineering" programme. The award is presented by manager magazin and Porsche Consulting and recognises companies that demonstrate outstanding, measurable business impact through the targeted application of artificial intelligence.

"I am extremely proud of our team and this recognition," says Elke Reichart, Member of the Management Board and Chief Digital and Sustainability Officer at Infineon. "This award validates our holistic approach to AI: as a technology provider as well as a technology user. We deploy artificial intelligence precisely where it creates measurable value for our customers and our business. The 'GenAI for Test Engineering' project is an excellent example of how Infineon effectively combines digitalisation and innovation to deliver greater benefit."

Infineon was recognised for its project "GenAI for Test Engineering – Automated Test Programming" in the category Manufacturing & Supply Chain. The project leverages purpose-built AI agents, multimodal large language models (LLMs), and domain-specific expertise to automate the generation of test code in semiconductor manufacturing. As a result, the time required to create software code for testing new semiconductor solutions can be reduced by 50% in the short term and by up to 80% in the long term. This represents a significant productivity gain for several hundred test engineers and makes an important contribution to faster time-to-market and higher product quality. Developed in close collaboration with test engineers, the solution is continuously monitored to ensure compliance with the Infineon AI Manifesto and ethical standards.

The AI Impact Award is jointly presented by manager magazin and Porsche Consulting and recognises outstanding AI solutions that demonstrably create economic value within companies and across industries. A jury composed of experts from industry associations, business, and academia evaluates submissions across three categories: Product & Customer Experience, Manufacturing & Supply Chain, and Organisation & Administration. The award-winning companies were honoured at a ceremony held at the ESO Supernova in Garching near Munich. Manager magazin will feature the winners in a dedicated editorial piece, presenting their achievements to a broad professional audience.

https://www.infineon.com/

Toshiba Extends TC75W Series of CMOS Dual Comparators for Overcurrent Detection in Industrial Equipment

Toshiba Electronics Europe ("Toshiba") has announced it has extended its TC75W series of CMOS dual comparators for overcurrent detection in industrial equipment, with the introduction of the TC75W71FU. Featuring high-speed response times and a full input/output range, the product enables immediate shutdown for enhanced operational safety and supports low-voltage operation. Target applications include industrial robots, photovoltaic systems, uninterruptible power supplies (UPS), and transformers.

The TC75W71FU delivers significant performance improvements over the existing TC75W56FU, particularly in propagation delay. The new device achieves a maximum delay of 45ns for low-to-high transitions and 30ns for high-to-low transitions compared to 550ns and 250ns, respectively, for the TC75W56FU. This high-speed response capability ensures that industrial systems can shut down immediately in the event of an overcurrent, thereby greatly enhancing operational safety.

To facilitate easier design integration, the TC75W71FU features a full input/output voltage range (rail-to-rail), allowing the component to operate effectively from the minimum supply voltage (GND) to the maximum supply voltage (Vcc). Furthermore, the device supports low-voltage operation with a minimum operating supply voltage of 1.8V, making it a versatile choice for a wide range of circuit requirements.

Expanding on this release, Toshiba has outlined plans for two additional models in the series, the TC75W72FU and the TC75W73FU, both were scheduled to enter mass production in February 2026. The upcoming TC75W72FU will feature increased hysteresis to improve noise immunity. The TC75W73FU will offer hysteresis and an open-drain output, enabling signal transmission to voltage domains outside the comparator's supply.

Housed in SOT-505 (SM8) packages, these comparators are suitable for industrial and consumer applications, including home appliances and power supplies. The series is rated for operation from -40 to 125°C and supports supply voltages from 1.8V to 5.5V.

Toshiba will continue to develop comparators that enhance the safety and reliability of industrial equipment while expanding its product lineup to meet a wide range of customer needs.

For more information about the new CMOS dual comparators, please visit: https://toshiba.semicon-storage.com/eu/semiconductor/product/linear-ics/operational-amplifiers-and-comparators/detail.TC75W71FU.html

https://toshiba.semicon-storage.com/eu/company/tee.html

Anritsu Fully Automates Hybrid eCall Automotive Emergency Call System Certification Tests

ANRITSU CORPORATION has announced it has launched a test solution compliant with the EN 18052:2025 Hybrid eCall certification standard that fully automates complex certification test cases. Automating complex standard-compliant test procedures, including communication system switching and multi-stage test sequences, using one-button operation, halves overall test times compared to conventional methods while assuring both reliability and high reproducibility.

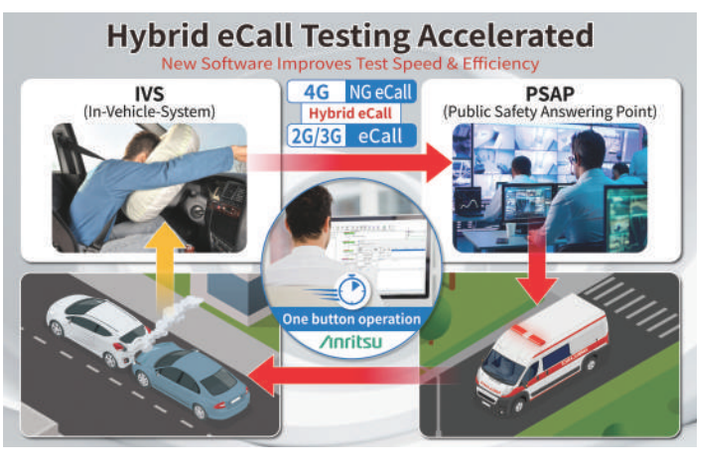
This industry first* solution has achieved EN 18052:2025 certification based on evaluation by cetecom advanced GmbH, a leading organisation in electronic equipment certification.

Hybrid eCall certification testing uses complex test setups due to the need for communication system switching and multi-stage test sequences. As a result, traditional testing is cumbersome and dependent on operator expertise, creating a significant burden during development and certification. Against this background, customers using Anritsu's measurement solution without automation made strong demands for test automation supporting error-free, repeatable execution and contributing to shorter development cycles.

To meet their needs, Anritsu has developed this new one-button test automation of complex standard-compliant tests, achieving significantly reduced test times. In addition, even novice operators can test reliably and repeatably under identical conditions to achieve consistent test quality. By improving overall operational efficiency, this solution supports all stages of in-vehicle system development right through to verification and certification.

*** For Hybrid eCall-compatible PSAP simulators (Anritsu survey, January 2026)**

http://www.anritsu.com



ASC Global Releases Q2 2026 Market Report: AI Infrastructure Triggers "Memory Supercycle" and Global Supply Chain Realignment

ASC Global, a leading global distributor of electronic components, has released its Q2 2026 Market Report, detailing a period of historic volatility and structural shifts within the semiconductor industry. The report highlights how the rapid expansion of Artificial Intelligence (AI) and a deepening operational crisis at Nexperia are reshaping procurement strategies for 2026 and beyond.

The "Memory Supercycle" and Production Cannibalization

As of April 2026, the memory market has transitioned from a shortage into a state of structural scarcity. High Bandwidth Memory (HBM) and Enterprise SSD production have effectively "cannibalized" lines previously dedicated to general-purpose DRAM and NAND.

- Unprecedented Price Surges: DRAM contract prices are projected to rise by 58 63% in Q2 2026 alone, while NAND Flash (SSD) prices may surge by up to 75%.
- The 70% Inversion: Analysts now estimate that AI data centers will consume approximately 70% of high-end DRAM in 2026, leaving minimal supply for industrial and consumer sectors.
- Extended Lead Times: Procurement teams are facing lead times of 40+ weeks for high-density RDIMM and enterprise configurations.

The Nexperia Crisis: An Operational "Divorce"

The report identifies a critical supply chain risk involving Nexperia, which has escalated into a near-total operational divorce between its European headquarters and Chinese subsidiary.

- Governance Conflict: In March 2026, Nexperia B.V. (Netherlands) disabled IT access for staff in China, citing unauthorized actions by Chinese management.
- Quality Risks: Nexperia HQ has warned that it cannot validate the authenticity or AEC-Q101 automotive-grade status of components produced in China using non validated local wafers.
- Global Realignment: Nexperia B.V. is fast-tracking a $300 million expansion in Malaysia to move 90% of global production out of China by mid-2026.

Industry-Wide Pricing Adjustments

Major manufacturers have announced significant price hikes effective April 1, 2026, to offset rising material and energy costs:

- Texas Instruments: Adjustments of up to 85% for specific analog power switches.
- Intel: CPU price hikes of up to 30% due to supply chain tightening.
- NXP: Broad price adjustments impacting automotive and industrial portfolios.

Strategic Recommendations for Procurement Leaders

"The shortage is no longer just a pricing issue; it is reshaping product lifecycles," states the report. ASC Global recommends that organizations consider Phase Buying - deferring non urgent purchases until late 2026 - and implement Frequent Re-Quoting, as quotes older than 14 days are now considered obsolete due to weekly price adjustments.

https://mro.ascglobal.com/mro-market-report/

Gallium Nitride Semiconductor Devices Market Size Worth USD 32.31 Billion by 2034 | CAGR: 26.8%

The global Gallium Nitride Semiconductor Devices Market is entering a decisive growth phase, driven by technological innovation, expanding applications in high-performance electronics, and widespread industry adoption. The latest market research indicates that gallium nitride (GaN) semiconductor devices are rapidly transforming the landscape of power electronics, RF communications, and high-efficiency systems — positioning GaN as a core component of next-generation semiconductor technology.

As a wide-bandgap semiconductor material, GaN offers compelling advantages over traditional silicon, including higher electron mobility, greater power density, and superior high-frequency performance. These properties make GaN devices essential in sectors ranging from 5G telecommunications and electric vehicles (EVs) to consumer electronics and renewable energy systems — all of which demand efficiency, miniaturisation, and reliability.

Explosive Market Growth Forecasts

The global GaN semiconductor devices market is poised for significant expansion through 2034, with demand driven by multiple high-growth applications. According to industry projections, the market is expected to grow to approximately USD 32.31 billion by 2034, reflecting a robust compound annual growth rate (CAGR) led by accelerating adoption across key industries.

This momentum is part of a broader industry trend toward wide-bandgap semiconductors that deliver higher energy efficiency, smaller form factors, and enhanced thermal performance, creating an ecosystem that increasingly favors GaN over legacy silicon technologies — especially in demanding use cases such as power conversion, RF amplification, and high-speed data transmission.

Drivers Fuelling GaN Adoption

A number of powerful market forces are propelling the adoption of GaN semiconductor devices:

5G Communication Systems:
The global rollout of 5G infrastructure is a major growth catalyst for GaN devices, particularly in RF and microwave components. GaN's ability to operate efficiently at high frequencies with low power loss makes it ideal for 5G base stations and massive-MIMO architectures — critical for supporting higher data rates and expanded network capacity.

Electric vehicles & Charging Infrastructure:
The rapid expansion of electric vehicle adoption and EV charging networks is creating strong demand for GaN power devices. These devices enable faster switching, increased energy efficiency, and reduced system size in onboard inverters and chargers, making them attractive for next-generation electrified mobility solutions.

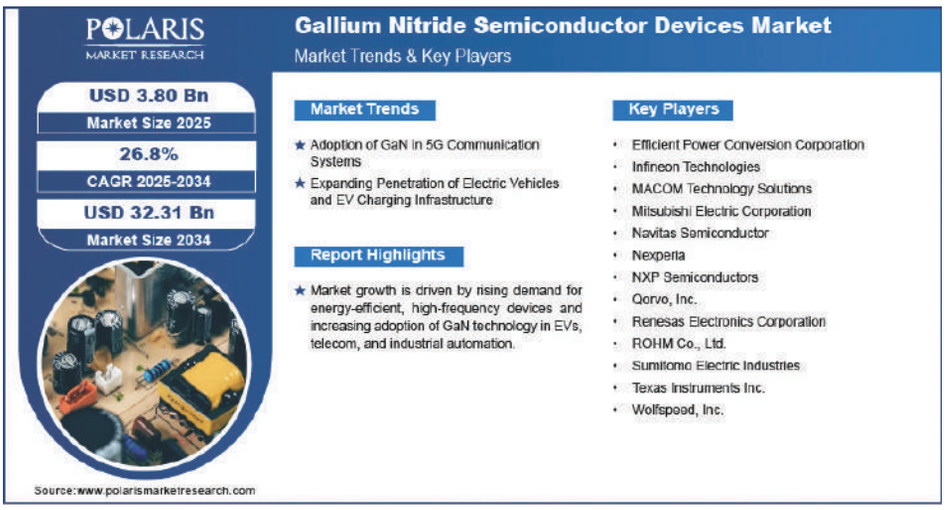
High-Efficiency Power Electronics:
Across consumer and industrial electronics, GaN power devices support compact, low-loss designs that improve energy conversion efficiency. From fast chargers for smartphones and laptops to high-performance data centre power supplies and renewable energy converters, GaN is delivering measurable operational advantages.

Market Segmentation & Trends
The GaN semiconductor market's growth is not uniform — several segments are emerging as leaders:

Power Devices & Transistors:
Power semiconductor components, including high-electron-mobility transistors (HEMTs) and integrated power ICs, dominate GaN device adoption due to their critical role in energy-efficient systems and converters.

RF & Communications Devices:
GaN RF devices continue to be highly sought after for telecommunications equipment, including amplifiers for 5G and satellite communications, where performance at high frequencies is essential.

Wafer Scaling & Manufacturing Innovation:
Advances in wafer production — including the shift toward larger wafer sizes and GaN-on-Si integration — are helping reduce manufacturing costs and improve output yields. This scaling trend is making GaN more competitive with silicon while enabling broader commercial adoption.



View more information -
https://www.polarismarketresearch.com/industry-analysis/gan-gallium-nitride-semiconductor-devices-market/request-for-sample

Regional Growth Dynamics
North America remains a dominant market for GaN semiconductor devices, supported by strong R&D capabilities, robust industrial infrastructure, and significant deployment of 5G, EV, and high-performance computing technologies.

Meanwhile, the Asia Pacific region is emerging as the fastest-growing market due to rising investments in telecommunications, automotive electrification, and consumer electronics. Countries such as China, Japan, and South Korea are aggressively increasing production capacity and technological innovation, further expanding regional market share.

Industry Outlook and Strategic Implications
The rise of GaN semiconductor devices represents a strategic shift for the entire Electronics, Semiconductors & Electronic Devices industry. Companies that embrace GaN technology stand to gain a competitive edge as markets transition toward solutions requiring higher efficiency, greater power density, and smaller footprints.

From telecom carriers upgrading to 5G infrastructure to EV manufacturers seeking energy-efficient power electronics, the advantages of GaN are being realised across a wide spectrum of applications. As supply chains mature and manufacturing processes scale, GaN is set to play an increasingly central role in the evolution of global electronics systems.

Conclusion: GaN at the Forefront of Semiconductor Innovation
As global demand for high-performance, energy-efficient electronics continues to rise, gallium nitride semiconductor devices are positioned at the forefront of this technological transformation. With strong growth projections, diversified applications, and accelerating adoption across industries, the GaN semiconductor devices market is not just expanding — it's reshaping the future of semiconductor technology.

Read more -
https://www.polarismarketresearch.com

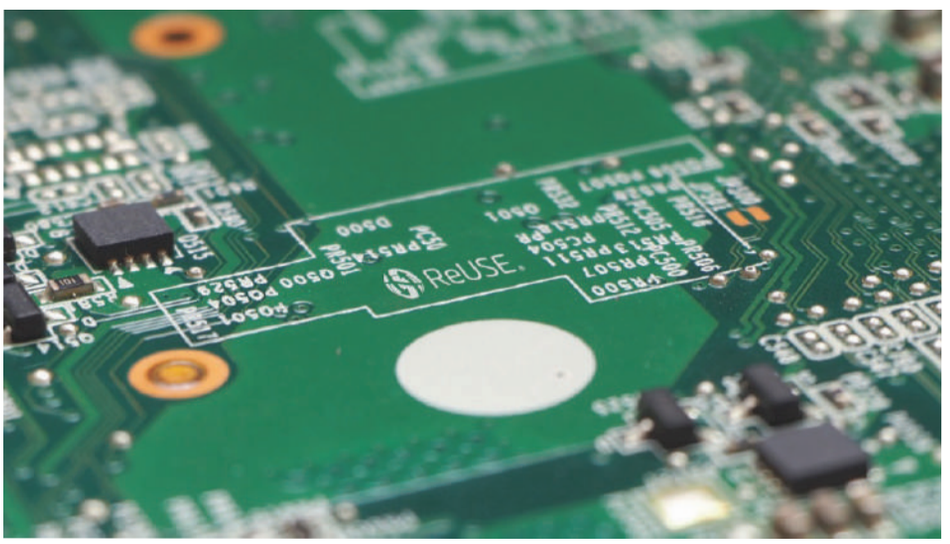
CIRCUIT FLAWED: Archaic PCBA design has a high failure rate – but there is a solution

Outdated circuit board designs have a high failure rate, and OEMs must find ways to tackle this massive cost burden if they are to thrive, warns a sustainable technology expert.

Conventional PCBA (printed circuit board assembly) processing has shockingly low yield rates that only technological innovation can overcome, warns Emma Armstrong, Sustainable Electronics Ambassador and Group Commercial Director at leading UK sustainable electronics provider In2tec.

She says poor soldering, incorrect component placement, contamination, defective materials, and human error are all factors that drive low yield rates.

"A higher-than-acceptable percentage of defective boards not only affects profitability but also disrupts production and customer satisfaction," Emma says. "Virgin manufacture has a failure rate of anywhere between 1-3% and defective units need to be scrapped – a huge cost burden."



"Meanwhile, the resources required to make PCBAs are dwindling, and the supply chains they require are vulnerable to volatility.

"Jettisoning limited and obsolete PCBAs is essential for forward-thinking manufacturers that want to maximise profit and meet their environmental responsibilities."

In2tec's mission is to offer an alternative to dated hardware that is incredibly difficult to reuse, repair, and recycle.

The company's ReUSE® tech is a series of materials, processes, and design principles used to manufacture modular PCBAs that can be fully unzipped at end-of-life or easily repaired.

"ReUSE® innovative plug-and-play design improves yield and, in turn, generates cost savings," Emma adds.

"The standardised process helps maintain quality, while optimised component placement and alignment reduce variability in production. As an added bonus, ReUSE® PCBAs can be tailor-made to fit efficiently into smaller and more ergonomically designed products."

Since 2001, In2tec has worked to slash the harrowing environmental and societal impact of ewaste and provide innovative solutions to the growing problem of throwaway electronics.

Discover more about In2tec's technology at https://in2tec.com/reuse

Molex Announces Agreement to Acquire Teramount to Accelerate Scalable Co-Packaged Optics Adoption

Molex, a global electronics leader and connectivity innovator, has announced an agreement to acquire Teramount, an Israel-based developer of detachable fibre-to-chip connectivity solutions optimised for high-volume Co-Packaged Optics (CPO) and other silicon photonics applications. Teramount's TeraVERSE platform, based on its universal photonic coupler and wafer-level self-aligning optics, provides a pragmatic, field-serviceable interface between optical fibre and silicon photonics chips and was recently announced as part of the Molex one-stop CPO solution at OFC 2026. TeraVERSE is an innovative, passively-aligned solution that enables faster data rates necessary to support AI adoption while consuming less energy to reduce power and cooling demands in hyperscale data centers.

"Teramount's TeraVERSE technology fills a crucial gap in the CPO stack, offering an advantaged and strategic complement to our optical solutions portfolio. With a practical, detachable fibre-to-chip interface we are afforded a foundational element to realise mainstream CPO adoption," said Aldo Lopez, President, Datacom Solutions, Molex. "Combining Teramount's IP and engineering talent with Molex's innovative portfolio, manufacturing scale, supply-chain expertise and systems know-how gives customers an integrated, high-volume path to deploy scalable CPO."

Teramount's passive, detachable coupling approach supports large assembly tolerances and semiconductor-grade wafer-level processes. Compared with active alignment methods, passive alignment is materially more scalable as CPO moves toward volume production. Molex will combine Teramount's IP and engineering expertise with its optical capability and global manufacturing scale to deliver industry-leading performance specifications and accelerate production of TeraVERSE.

"Harnessing Molex's global scale and system-level expertise with Teramount's innovation expertise and detachable, wafer-level coupling technology creates a real pathway for scalable, high-density CPO," said Hesham Taha, CEO and Co-Founder of Teramount. "Joining forces with Molex will enable us to accelerate delivery of a manufacturable, serviceable fibre-to-chip interface that meets the pressing needs of AI and hyperscale data centres."

The addition of TeraVERSE to Molex's comprehensive optical interconnect portfolio provides customers with greater support across their CPO and silicon photonics architectures. As a leader in high-speed communications interconnects, Molex says it is uniquely positioned to deliver industry-leading copper and optical solutions.

Teramount will remain a design and engineering center in Jerusalem supported by Molex's global optical capabilities. The acquisition is expected to close in the first half of 2026, subject to regulatory approvals and other customary closing conditions.

https://www.molex.com/

PCIM 2026

PCIM Expo & Conference 2026: Discover the Future of Power Electronics

From 9 – 11 June 2026, Nuremberg will once again become the international hub for power electronics. The PCIM Expo & Conference brings together experts from around the world to discuss the latest developments and future trends in the industry. The event provides a comprehensive overview of the innovative products, solutions, and trends that will help shape the power electronics industry in the future. This year, for the first time, a new stage will shine a light on the topic of artificial intelligence and data centres.

Across approximately 40,000 square metres of exhibition space, more than 650 companies from 27 countries will be showcasing their newest and most tried-and-tested technologies. Leading companies such as Mitsubishi, Onsemi, Sumida, and Toshiba will all be in attendance. These will be joined by an array of newcomers, including Allegro MicroSystems, NHK Spring, and Moteon, all of whom will also present their latest innovations. A complete list of this year's exhibiting companies, as well as the products and solutions they will be presenting, is available in the online exhibitor search on the PCIM website.

Wide range of presentations across four stages

This year, a new presentation stage, the AI & Data Centres Stage, will be joining the Exhibitor, Technology, and E-Mobility & Energy Storage stages at the PCIM Expo 2026 to shine a light on two of the most important future trends in power electronics. The expert presentations and panel discussions will give visitors in-depth insights into current developments, innovative technologies, and practical applications.

Each stage has a different focus to offer a broad selection of illuminating presentations.

Highlights of the Technology Stage

- Fraunhofer IISB: 1200V SiC High-Temperature Power Module as Reference Development Platform
- Fraunhofer IAF: Scaling up the Power of GaN Technologies: Paving the Way for the 1200 V Class and Beyond
- Bosch: Maximizing SiC Power – Is Double-Sided Cooling the Right Choice?
- Infineon: Optimizing Soft-Switching Operation of GaN at High Frequency

Highlights of the AI & Data Centres Stage:

- Yole: GaN Powering the AI Data Centre: Enabling Efficient Next-Generation Power Delivery
- ECPE: White Paper on AI in Power Electronics

The E-Mobility & Energy Storage Stage will focus on current and future developments in power electronics for use in electromobility and energy storage. This year, leading companies such as Wolfspeed, Hitachi, and Littelfuse will introduce their applications.

University Research Zone to showcase innovations from academia

At the PCIM Expo 2026, the University Research Zone will offer exclusive access to the most recent findings from power electronics research. Each day will feature different universities and research institutes offering insights into the latest developments from the world of research.

Below are just some of the universities that will be presenting recent projects:

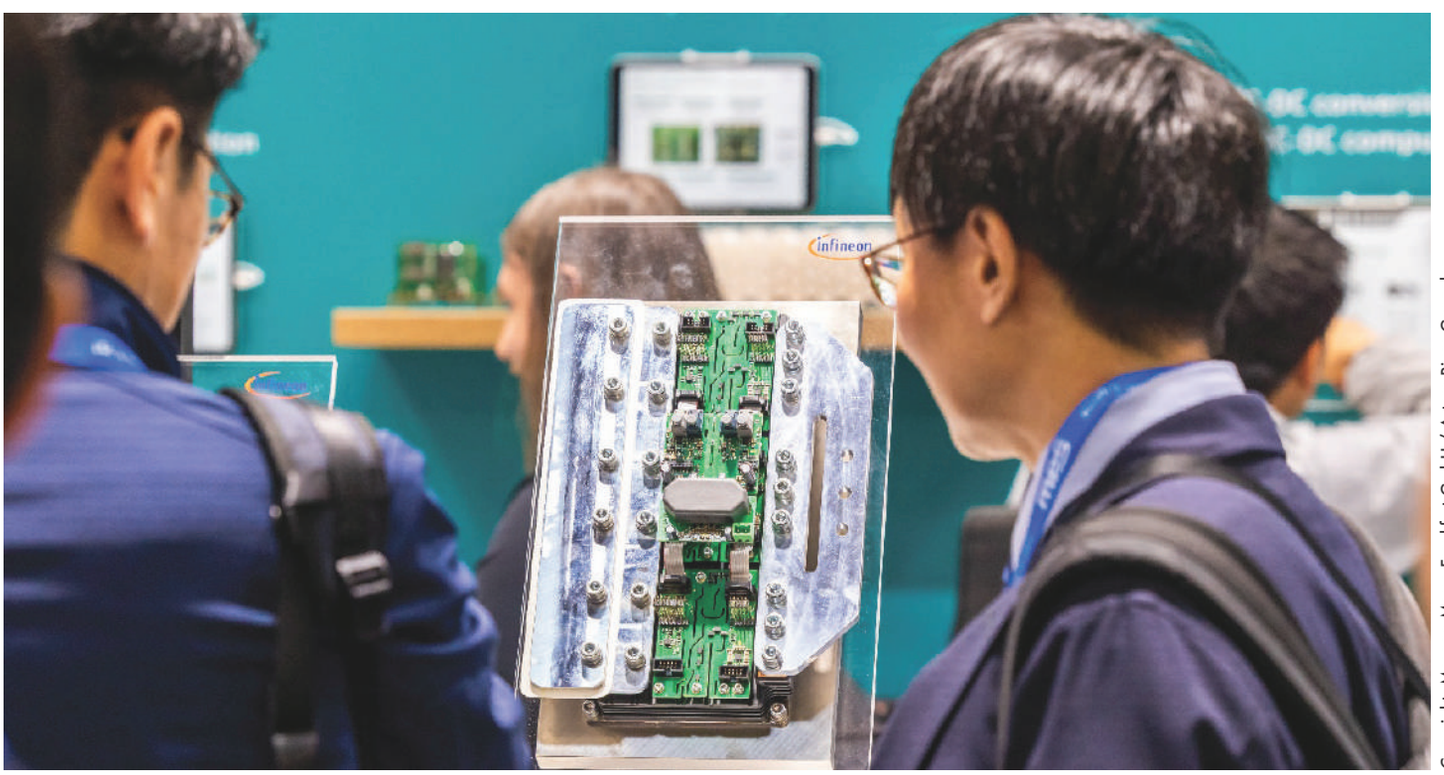
- Stuttgart University: Advanced Wide-Bandgap Semiconductor Reliability Characterisation and System Design
- University of Edinburgh: Advancing Wide-Bandgap Power Semiconductors to MW-Class Converter Applications
- University of Southern Denmark: New Generation Electrolytic and Film Capacitors

Conference highlights: a spotlight on artificial intelligence and future-oriented innovations

As usual, the PCIM Expo will be accompanied by the PCIM Conference – an exclusive platform that promotes exchange between the realms of industry and science. Participants can look forward to an extensive line-up of first-rate talks and poster presentations – including numerous first publications from industry and science – that will surpass 500 for the first time.

In addition, the PCIM seminars, which are held over the two days before the exhibition, offer a unique setting for direct discussion of specialized topics along the entire power electronics value chain.

For more information, please visit the homepage of the PCIM – Hub for Power Electronics.



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11 ways to fine tune your high-voltage-to-48V power conversion

By Maury Wood, VP Strategic Marketing at Vicor

Today's new and existing electrification applications in the industrial, automotive, data center and defense sectors require more power. They are driving the need for higher voltages and conversion to lower DC SELV (safety extra-low voltage) levels – defined as below 50VDC. Often SELV level is 48VDC or 28VDC .

High-voltage-to-SELV applications

High voltage (HV) DC applications include 400V or 800V electric vehicle battery packs, AI data center 400V or 800V distribution to racks, with both electrical system architectures often converting to 48V. These principal HV-to-SELV use cases have created an ecosystem of components such as DC-DC converters, competence and know-how, and successful system design and deployment.[j1]Other HV to SELV application examples include solar and fuel cell power generation, long-distance subsea cables, large industrial robots, medical imaging systems, shipboard and aircraft power distribution, semiconductor ion implantation equipment. Telecom equipment has used -48VDC battery backup for decades, derived from 300VDC rectified from 220VAC from the utility grid.

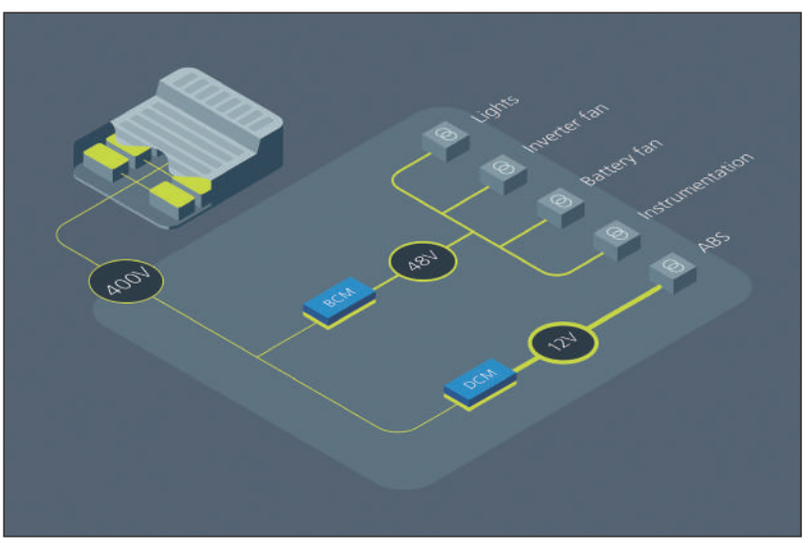

Figure 1: A light electric vehicle's power delivery network converts a high-voltage battery source to a 48V bus using a fixed-ratio DC-DC Bus Converter Module (BCM).[j2]

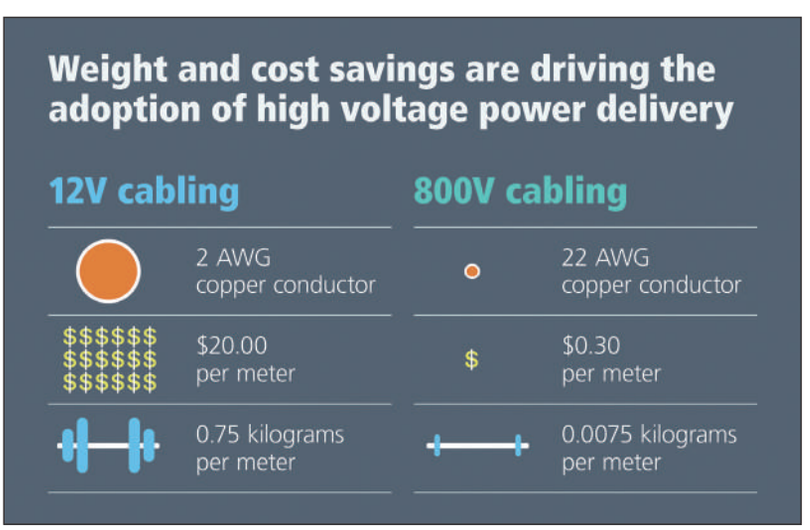

Figure 2: High-voltage cabling provides not only low cost, but also higher efficiency and critical weight savings for products that require longer runtime. All other electrical parameters assumed equal (specifically cable resistance), 12V cabling dissipates 16x the losses of 48V cabling while delivering the same power to the load.

Thinner, lighter 48V cabling lowers thermal power losses

Unlike AC transmission systems such as utility grids, DC transmission systems do not have an electrically reactive (capacitive and inductive) component and are thus generally more efficient. DC distribution is purely resistive. (AC distribution also experiences resistive losses.) High-voltage cables have lower conductive thermal losses (I^2R), are thinner and lighter and use less copper, an expensive commodity base metal due to the explosion of AI data centers among other factors.

For example, to carry the same level of power, a 12V cable needs to carry 64x more current than an 800V cable. The 12V cable might use a 2 AWG copper conductor (approximately $20 per meter) while the 800V cable might use a 22 AWG copper conductor (approximately $0.30 per meter), which is obviously a substantial cost difference for long cable runs. Furthermore, the weight difference between 2 AWG cable and 22 AWG cable is about 0.2kg per meter. These key factors are driving the increasing adoption of DC power delivery, particularly in platforms in which are weight and cost sensitive.

Resistive thermal dissipation in the cables used for high-power distribution can also be a major OPEX consideration beyond the CAPEX savings described above. Due to the extremely high power levels in AI data centers in the assessment of the Power Usage Effectiveness (PUE) of AI data centers, for example, approximately 6% of the incoming AC grid power is

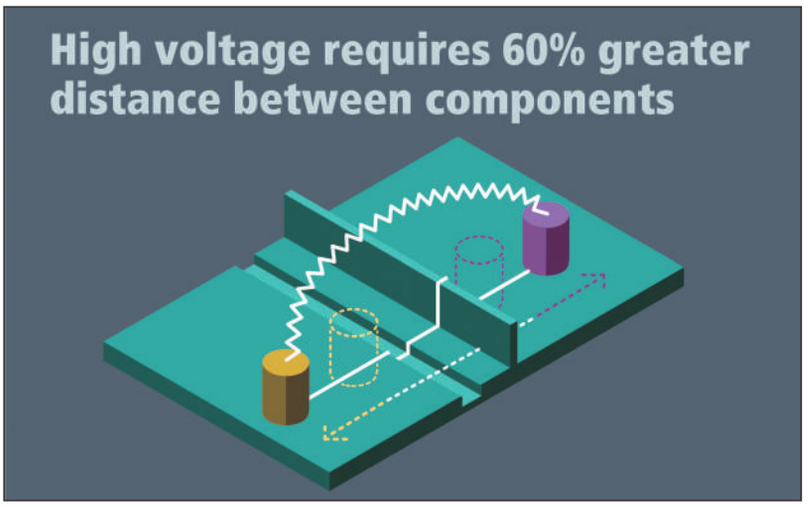

Figure 3 Right: Creepage and clearance requirements are international safety measures to mitigate the risk of arcing. Lack of proper distancing may result in excess heat, directly damaging or compromising the power delivery network. Higher voltage requires up to 60% greater space in between components, a specification at odds with designing for a smaller power delivery footprint.

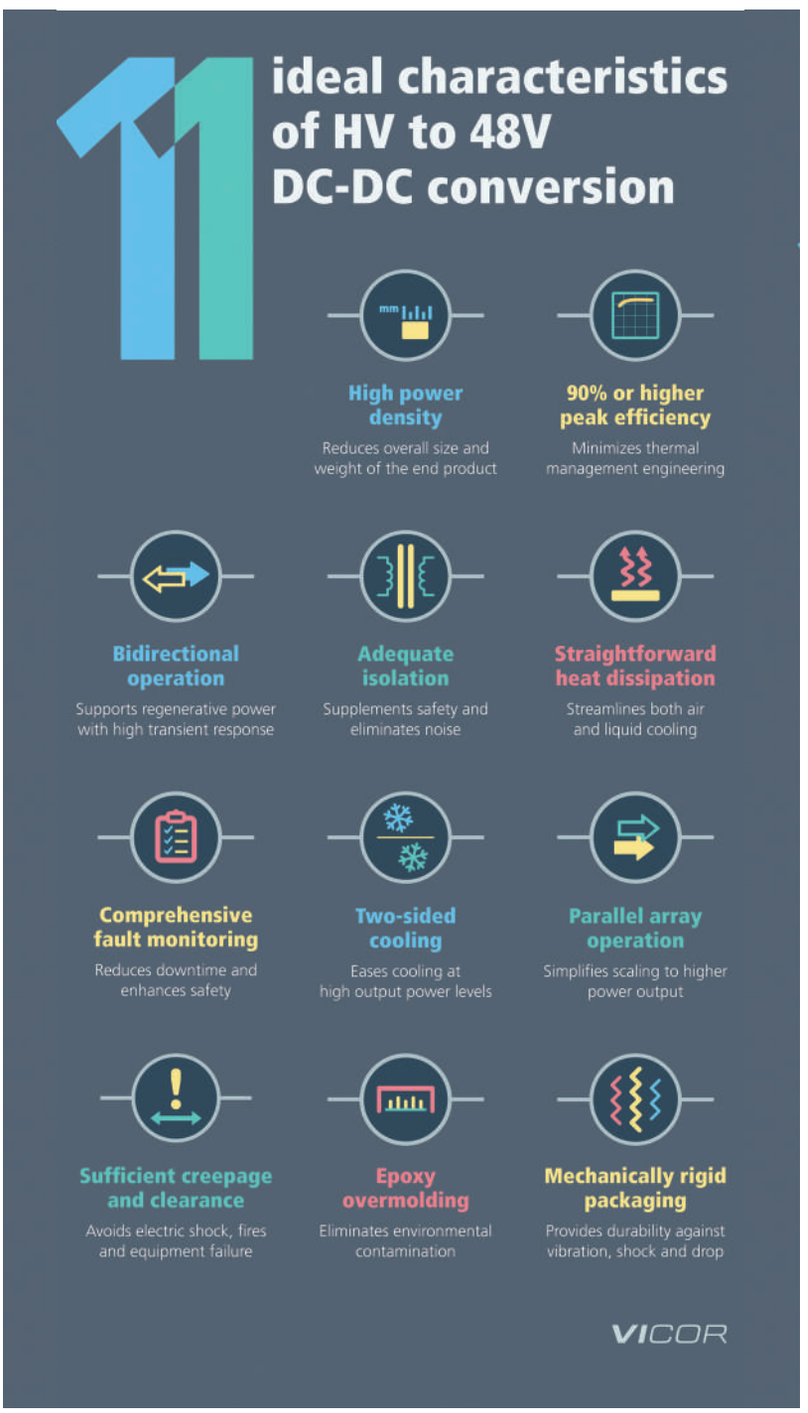

Figure 4 Left: There are 11 important requirements to keep in mind when designinig a power delivery network that is converting high voltage to a 48V bus.

consumed by power conversion losses. If high-voltage distribution to the rack saves just 1% of this power conversion (a conservative estimate), then for a 1GW system, it represents a savings of 10MW. At $50 per MW/hr x 8,760hr/yr, this is $438k OPEX savings per year. Depending on the source of the energy, this is also a substantial reduction of greenhouse gases. Using natural gas power generation for comparison, 10MW produces about 4,000kg of CO_2 per hour or 35Mkg per year.

Technical considerations for high-voltage DC

High-voltage conductors are often identified (to technicians and first responders) with orange insulation for safety reasons. This can be easily observed in electric vehicles.

High voltage sources must be galvanically isolated for human and system safety; isolation also eliminates ground loops and reduces noise. This is critically important. The isolation should be 2x to 4x working voltage isolation (conservatively 3.2kV for 800V applications).

Other challenges with high-voltage DC includes providing sufficient creepage (the shortest distance along the surface of an insulator between two conductors) and clearance (the shortest distance through the air between two conductors) for electrical safety concerns such as electric shock, fires and equipment failure. This applies both to discretely-implemented solutions and modular solutions. Insufficient creepage or clearance can cause arcing, shorts and breakdowns, particularly at high voltages and as environmental

contamination increases over time. UL and IEC safety standards require sufficient creepage and clearance to ensure product reliability.

Converting high voltage to 48V efficiently using the Vicor 48V power delivery ecosystem

To help accelerate the adoption of 48V PDNs, Vicor has developed a comprehensive ecosystem of power modules optimized for 48V applications. These modules are characterized by high power density (W/in3) and high current density (A/mm2). The Vicor modular approach enables designers to architect end-to-end 48V systems using building blocks that are:

- Extremely compact and power dense to enable form-factor flexibility
- Highly efficient across a wide load range to minimize end-user operating costs
- Electrically isolated where needed to ensure safety standards compliance
- Thermally optimized using modern packaging to minimize heat removal hardware

Thermally adept module packages, combined with high functional integration shortens design cycles, reduces engineering risk and enables scalable designs across a wide range of power levels.

The Vicor portfolio includes solutions for all three elements of the 48V ecosystem:

- Converting high voltage to 48V
- Converting 48V-to-PoL voltages
- Bridging 48V and legacy 12V systems

Vicor isolated fixed-ratio BCM® bus converters and isolated regulated DCM™ DC-DC converters provide efficient front-end conversion which delivers a reliable backbone for your 48V power delivery network.

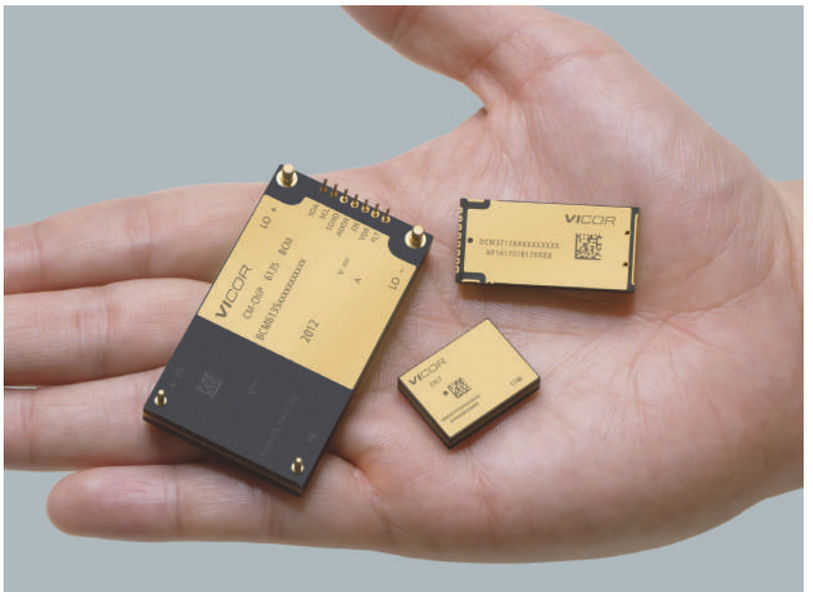

Figure 5: Vicor high-performance power modules provide kilowatts of power in a small space.

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Power with purpose: How today's charging systems are shaping safety-critical design

By Dag Pedersen, Marketing Manager, Mascot AS

Modern battery charging systems for industrial and medical equipment have evolved far beyond simple power supplies. These vital system components now play a decisive role in determining key design ambitions like safety, reliability and system lifetime, particularly in applications where equipment must operate continuously under demanding conditions and comply with stringent global standards. For engineers developing safety-critical, battery-powered solutions, charger design has become a fundamental system consideration.

Be safe, not sorry

Safety is the most immediate and prominent area of charger influence. Industrial and medical equipment increasingly relies on battery chemistries with high energy density, especially lithium-ion variants, which provide gains in energy storage but introduce certain challenges without proper management. Overcharging, overheating or cell damage can trigger thermal runaway, making the battery charger the first line of defence against catastrophic failure.

Modern chargers serve as active safety systems, monitoring voltage, current and temperature, and responding accordingly. Microprocessor-based control enables chargers to shut down, taper current or adjust charging behaviour upon detecting unsafe conditions, reducing the likelihood of hazardous events like fire.

The active safety role extends to multi-stage charging profiles, particularly for lithium-ion batteries, supporting energy efficiency while avoiding the stress associated with abrupt or uncontrolled charging. In a best-practice example of a multi-step charging profile, stage 1 (boost/constant current) would see the charger operate at maximum current, delivering about 70-80% of the charge; stage 2 (absorption/constant voltage) would involve the charger switching to a lower, constant voltage, topping off the battery (to approximately 85-100%); while in stage 3 (float/maintenance – for Lead Acid and LiFePO4, not Li-Ion), the charger would enter a low-current float charge to keep the battery full without causing damage. Different LED colours typically provide visual indicators of the various stages.

In medical environments, the multi-stage charging approach is reinforced by compliance with strict safety standards that mandate robust protection against electrical and thermal hazards. Industrial systems face parallel challenges, including the need to control hydrogen gas generation in lead-acid batteries or manage heat in high-power installations such as forklifts and automated guided vehicles (AGVs).

Conversely, the use of low-quality or non-certified chargers remains a leading cause of battery failure, often resulting in fire risk, hazardous gas release or sudden power loss in safety-critical equipment.

Trust the process

Beyond safety, charging systems also influence reliability. Modern chargers no longer simply replenish energy; they actively manage battery health to prevent premature degradation and unplanned downtime. Charging algorithms decrease stress on battery cells, while temperature monitoring permits systems to reduce or suspend charging when approaching thermal limits. Automated transition to maintenance/float mode eliminates dependence on operator judgement and prevents damage caused by overcharging or prolonged high-voltage exposure.

Chargers increasingly offer diagnostics and data logging, facilitating the adoption of predictive maintenance strategies that identify declining battery health before failures occur.

The implications for enhanced reliability extend across both industrial and medical applications. In the latter, the dependable charging of battery-driven equipment such as ventilators, infusion pumps and defibrillators, directly underpins patient safety by ensuring batteries perform as expected during critical or extended procedures. Within industrial environments, automated control reduces manual intervention and protects high-value battery packs.

Secrets to long life

Total system lifetime is where the cumulative impact of charger design becomes most apparent. Battery lifespan is frequently the restricting factor in the total service life of industrial and medical equipment, with charging behaviour a primary determinant of how rapidly lifespan elapses.

Among key factors here is excess heat, which remains one of the most destructive influences on battery chemistry, accelerating ageing and reducing capacity. By dynamically adjusting current, employing pulse-charging techniques and tailoring charging profiles to specific chemistries, modern chargers reduce internal heat generation and slow long-term degradation.

Carefully managed charging windows also have a role to play. Maintaining a lithium-ion battery within a moderate state-of-charge range, rather than continually cycling between empty and full, can extend lifecycle. This approach has been shown to double operational battery life in some industrial use cases, while in medical devices it can reduce failure rates and improve availability.

Leading the charge

At the core of these improvements lie charging algorithms. By managing temperature, voltage and current with greater precision than legacy designs, algorithms mitigate failure mechanisms such as lithium plating during rapid charging and electrolyte breakdown at elevated temperatures.

Subtle changes, like limiting peak charge voltage or tapering current more robustly as full capacity approaches, can yield gains in longevity without compromising performance. For lead-acid systems, multi-stage charging reduces sulphation and electrolyte loss, while lithium-based

chemistries benefit from adaptive current control that balances speed with long-term health.

Thermal and electrical stress management further reinforces these advantages. Active cooling, intelligent thermal control and effective heat spreading within charger circuitry prevent hotspots that can otherwise undermine reliability. Electrical strategies such as cell balancing, whether passive or active, ensure no single cell becomes a weak link that restricts pack performance. Together, these measures uphold uniform operating conditions across the battery, reducing uneven ageing and improving predictability.

Compliance with safety and electromagnetic compatibility (EMC) standards is another non-negotiable requirement in industrial and medical environments. Modern charging systems should be designed to meet standards such as IEC 60601-1 (safety and essential performance of medical electrical equipment), IEC 60335-2-29 (safety of industrial battery chargers) and the IEC 60601-1-2 series (EMC for electrical and electronic equipment).

Intelligent control, reinforced insulation, medical-grade isolation, and carefully engineered filtering allow chargers to operate safely alongside sensitive electronics without generating disruptive interference or succumbing to external electrical disturbances. Robust mechanical design – including protection against dust, moisture and vibration – also support consistent performance.

Overcoming design pitfalls

Despite these advances, common design pitfalls continue to undermine reliability and inflate lifecycle costs. Inadequate thermal management, low-accuracy sensing, simplistic charging practices and poor physical integration frequently lead to quicker ageing and unexpected failures. Aggressive fast charging without sufficient thermal control, continuous operation at full state of charge and generic chargers that ignore chemistry-specific requirements are especially damaging. Mechanical oversights, like failing to allow for cell expansion or designing systems that are challenging to service, further increase downtime and maintenance costs.

Avoiding these pitfalls requires a defined system-level approach. Battery management, predictive diagnostics, optimised charging profiles, and comprehensive thermal and mechanical design all contribute to longer service life and lower total cost of ownership.

Within this landscape, Mascot's latest generation of battery chargers illustrate how modern design principles translate into practical solutions. The company's microprocessor-managed chargers support multiple battery chemistries, employ multi-stage charging with soft-start and automatic termination, and incorporate comprehensive protection features aligned with medical and industrial standards. The flexibility, global compatibility and configurable parameters of Mascot chargers reflect the direction of travel for this technology in safety-critical equipment.

Fundamental technology

Battery charging systems have become central to the safety, reliability and longevity of industrial and medical equipment. For design engineers, informed charger selection is no longer optional but fundamental to system performance and compliance. By prioritising intelligent control, thermal awareness, chemistry-specific charging and robust conformance with standards, engineers can reduce risk, extend operational life and lower total cost of ownership. Only this way is it possible to ensure battery-powered systems perform safely and predictably across their intended service life.Top of Form

Rethinking Data Centre Power Infrastructure for the AI Era

The rapid growth of AI being integrated into our digital landscape is reshaping how power is designed, delivered, and managed inside modern data centres. What was once a rather linear challenge - securing capacity and distributing power - has now become more complex.

Higher rack densities, constrained delivery timelines, and the need for more efficient and resilient power is now pushing traditional power infrastructures to their limits. Across Europe, operators are recognising the importance that power has become in constraining data centre growth. But the question is more on how quickly it can be deployed, efficiently managed, and how reliably it can support AI-focused workloads over time, rather than just how much power can be secured.

The Power Challenge Behind the AI Boom

The AI boom presents a unique opportunity for the data centre sector, with around £2.2 trillion expected to be spent on AI data centres between now and 2029. However, this development will need the industry to adapt to its power and its availability.

The electrical power path from the grid to IT workloads must now manage more complex protection strategies and increasingly dense environments, and with this, operators are under pressure to improve efficiency and gain a clearer visibility in how power is being consumed. This has accelerated the move towards higher-density distribution designs engineered for improved efficiency. These methods also demand an increased level of coordination between power electronics, protection systems, and control platforms.

Traditional Methods but Emerging Challenges

Despite the evolving demands, many data centres continue to deliver using fragmented power systems assembled on site. Switchgear, transformers, UPS systems, and monitoring platforms are often designed and manufactured in isolation, then integrated under extreme time pressure during construction.

The risks associated with this approach are becoming more visible, with long lead times, shortages of specialist talent, and complexity of commissioning evident in the process as the common causes for delay. Each additional interface increases the likelihood of errors at a time when the speed to market is more critical than before. Fragmentation also limits optimisation. When power systems are not engineered as one system, opportunities to streamline conversion stages or embed smarter monitoring from the outset are often missed. The result is infrastructure that works, but harder to operate, scale and adapt as load profiles change.

The New Way of Thinking: Integrated Power Delivery

From this, our industry is beginning to adopt a different model that recognises the shift to modular, off-site construction. TES Group is at the forefront of this transition, delivering integrated, off-site manufactured power distribution systems for large-scale data centre projects across Europe. Rather than assembling electrical infrastructure separately on site, TES Group designs and manufactures completed power systems as a unified platform.

These modular electrical rooms and

skid-mounted units bring major power components, including transformers, low-voltage distribution, UPS, together in one engineered system. These are then built, integrated, and tested in a controlled environment, where the full electrical design can be optimised. By shifting this work off site, the complexity challenge is removed from the construction phase - each system is assembled and put through comprehensive Factory Acceptance Testing before delivery, reducing commissioning time and giving operators greater confidence in performance and reliability.

Designing for Speed, Scale and Operations

Off-site manufactured power systems also align closely with how data centres are being built in today's digital ecosystem. Modular power infrastructure can be manufactured whilst the facility is being constructed, reducing project schedules and exposure to on-site labour constraints. This is particularly valuable as data centre development expands into new European markets, where access to those equipped with specialist electrical skills may be limited, helping to encourage new talent into the industry.

Power as the Backbone of Future Growth

In this booming era of AI, power infrastructures need to function as a resilient necessity capable of supporting evolving infrastructures. By combining design and manufacturing with delivery, operators can reduce lead times and regain control over one of the most critical elements of their data centres.

As AI continues to reshape the data centre landscape, streamlining power management may prove to be one of the most effective ways to build faster and future-proof for the next generation of data centres.

The APEC 2026 conference in San Antonio, Texas (March 22–26) highlighted rapid advancements in AI data centre power, Wide Bandgap (WBG) semiconductors (GaN/SiC), and passive component trends. The event, featuring record participation, showcased 800VDC power delivery to GPUs and SiC modules up to 3.3kV.

Key Trends & Technical Takeaways

- AI Data Centre Power: A major focus was on moving 800VDC closer to GPUs for higher efficiency, with companies like Navitas presenting 5th-gen GaN/SiC technology for better thermal efficiency in high-power applications.
- Wide Bandgap (WBG) Dominance: GaN and SiC continue to replace silicon in high-efficiency applications, moving from adoption to optimisation.
- Passive Components Evolution: The shift toward higher frequency and density necessitates advanced,, smaller passive components, increasing demand for specialised magnetics and capacitors.
- Technical Sessions: Key discussions covered transient mitigation techniques like Z-Axis Power Delivery (ZPD) and Trans-Inductor Voltage Regulators (TLVR).

Highlights

- Record Participation: The event featured over 1,200 submitted digests and a packed exhibit hall with 263 exhibitors.
- Student Focus: The 2026 conference introduced a Student Demonstration Competition alongside traditional job fairs and mentorship programs.
- Interactive Learning: Attendees highlighted the value of technical sessions and n-etworking opportunities.

APEC 2026 reinforced several core themes: relentless pressure for higher efficiency, higher power density, smaller solution size, and simpler designin. Device vendors showcased GaN and SiC switches, integrated power stages, and new control ICs targeting AI data centres, EV onboard chargers, robotics, industrial automation, and highend appliances. Bidirectional switch concepts, in particular, were highlighted as a way to enable new topologies such as matrix converters and singlestage ACDC architectures.

For passive components, these systemlevel themes translate into:

- Higher switching frequencies, which reduce magnetic size but demand lowloss cores and lower parasitics.
- Higher bus voltages (400–800 V and beyond) and more bidirectional energy flow, which change stress profiles on capacitors and magnetics.
- Tighter EMI and functionalsafety requirements, pushing more sophisticated filtering, isolation and surge protection components into every design


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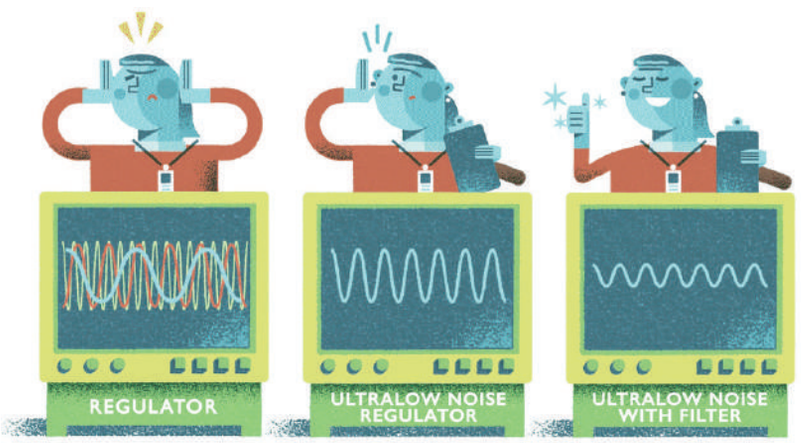
E: damien.oxlee@dfamedia.co.uk
www.dfamedia.co.uk

How to Optimise a Second-Order Output Filter for an Ultralow Noise µModule Regulator

George (Zhijun) Qian, Senior Analog Design Engineering Manager, and Jennifer Florence Joseph Benedicto, Senior Design Evaluation Engineer, Analog Devices

Question

Can we further reduce the output switching noise of an ultralow noise µModule® regulator?



Answer

The output noise of an ultralow noise µModule regulator can be reduced by over 90% using a second-order output filter. Proper care must be taken to select the capacitor and inductor components to maintain fast and stable control loop. This design is particularly beneficial for wireless and RF applications, where a fast transient response minimises system blanking time and maximises signal processing efficiency. This methodology achieves noise levels comparable to an LDO with the efficiency of a switching regulator.

Introduction

Power consumption for noise sensitive devices is increasingly growing. Applications such as medical ultrasound imaging systems, 5G transceivers, and automatic test equipment (ATE) demand high output current (>5A) with a low noise level and high bandwidth in a small PCB area. Due to the high output current demand, the traditional two stage (buck + low dropout (LDO) regulator) solution that was previously used requires more PCB area and incurs more power loss, making it less preferred.

The LTM4702 ultralow noise µModule regulator features Analog Devices' proprietary Silent Switcher® technology, an ultrafast transient response, and ultralow noise architecture. All these features make it ideal for high current and noise-sensitive applications, while still maintaining the high efficiency of a synchronous switching regulator. This solution could eliminate LDO circuitry for many applications, which saves LDO cost (~60%), LDO power loss (4W and up), and LDO PCB space (2cm2 + clearance).

For certain applications requiring a very small switching frequency ripple, it is well known that a second-order LC filter can reduce the switching frequency harmonics of the output voltage. However, the design challenge is minimising the switching ripple while still maintaining a stable control loop with high control loop bandwidth. Often, the control loop becomes unstable after adding an un-optimised LC filter, which causes the output to oscillate. In this article, a simplified loop analysis of the second-order LC filter is first discussed, and then an intuitive design method is given to guide on capacitance distribution and inductance calculation. Lastly, the LTM4702 design example verifies the proposed design method.

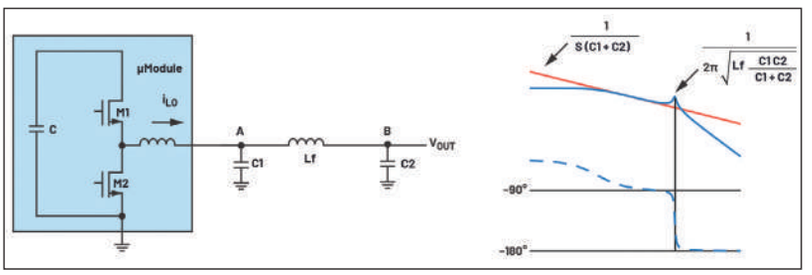


Figure 1. A current-mode buck regulator along with a second-order LC and its typical Bode plot.

Loop Analysis of a Second-Order LC Output Filter Design

In a current-mode buck regulator, the output impedance is the control plant. Figure 1 shows the circuitry of a second-order LC and its typical Bode plot. To maintain accurate DC voltage regulation at load, VOUT remote node B is sensed.

The transfer function from V_{OUT} to i_{LO} is:

$$\frac{V_{OUT}(S)}{i_{LO}(S)} = \frac{1}{[(C1+C2)S](1+Lf\frac{C1C2}{C1+C2}S^2)} \quad (1)$$

From the transfer function (Equation 1), the second-order LC filter will introduce double poles with resonant frequency.

$$\text{Fresonant} = \frac{1}{2\pi\sqrt{Lf\frac{C1C2}{C1+C2}}} \quad (2)$$

From the typical Bode plot shown in Figure 1, there is a sharp 90° phase delay at the resonant frequency. To ensure stability, the resonant frequency should be 4 to 5 times higher than the control loop bandwidth. This is to avoid a 90° phase delay that could cause instability. Also, to provide enough attenuation for the switching frequency ripple, this resonant frequency should be set 4 to 5 times lower than the switching frequency so the LC filter can provide enough filtering. There is a trade-off between attenuation gain at switching frequency and the control loop bandwidth. However, this methodology helps in selecting a resonant frequency with the optimal LC value.

To maintain similar load transient performance, the output impedance should remain consistent before and after adding the LC filter. This means the output capacitance should be roughly the same with or without the LC filter. As a rule of thumb, the capacitance of C2 in Figure 1 can be kept similar to the design without the LC, and C1 can use a much smaller capacitance value so that C1 can dominate the resonant frequency location. Since C1 is much smaller than C2, Equation 2 can simplify into Equation 3:

$$\frac{1}{2\pi\sqrt{Lf\frac{C1C2}{C1+C2}}} \approx \frac{1}{2\pi\sqrt{LfC1}} \quad (3)$$

C1 is recommended to be at least one-tenth the value of C2. Once C1 is chosen, the Lf value can be calculated using the resonant frequency in Equation 3. By checking the availability of real components, the optimum C1 and Lf values can be decided.

Components Selection Considerations

The selections of the capacitor and inductor components are critical in an effective second-order LC filter design. The second-order LC filter needs to provide large enough attenuation at the switching frequency. Since the switching frequency is high (1MHz to 3MHz) in an ultralow noise µModule regulator, the inductor and capacitor in the second-order LC require a good high frequency characteristic. The C2 selection requirement is similar to the design without the LC, so it is not discussed here. The C1 and Lf selection criteria is provided below.

■ C1 capacitor selection criteria.

1. The self-resonant frequency of C1 must be higher than the switching frequency. The impedance of C1 at the switching frequency is the key factor for the second-order LC design. A ceramic capacitor is recommended, and its impedance vs. frequency curve can be referred to determine its self-resonant frequency. Usually, a typical 0603 or 0805 size ceramic capacitor would be ideal, and their self-resonant frequency must be above 3MHz.
2. The rms current rating should be high enough to withstand the current flow. Assuming that all the AC ripple goes through C1, the ceramic capacitor should be able to handle a large rms ripple current. The ceramic capacitor's temperature rise vs. current curve can be referred to determine current capability. For a 0603 size capacitor, ~4Arms is a good rule of thumb.

■ Lf inductor selection criteria

1. For output current below 8A, a ferrite bead is recommended due to its great high frequency characteristic and compact size. Ferrite beads are also helpful to dampen very high frequency spikes.[1] For output current above 8A, or if a large inductance is required, it can be difficult to find a proper ferrite bead, so the traditional shielded inductor is recommended.
2. Select a ferrite bead/inductor with a sufficient rms current rating (for example, 8Arms current rating for output current below 8A). The inductor value is recommended to be less than 10% of the inductor of the µModule device.

Ultralow Noise µModule Design Example

Figure 2 shows a design example of the LTM4702. It features ultralow electromagnetic interference (EMI) emissions and ultralow rms noise. Its switching frequency is adjustable from 300kHz to 3MHz. In the design example, it is set to 2MHz to optimise noise performance for a 12VIN to 1VOUT application. According to the proposed LC filter design method, the resonant frequency of a second-order LC is set to 400kHz to 500kHz, 4 to 5 times smaller than the switching frequency.

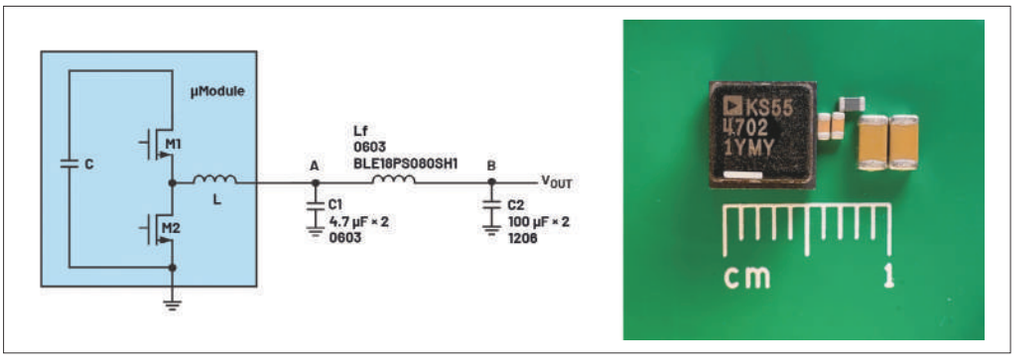


Figure 2. The LTM4702 example circuit and a board photo.

The target control loop bandwidth is 100kHz, 4 to 5 times smaller than the LC resonant frequency. Two 0603 4.7µF capacitors are used for C1. Ferrite bead BLE18PS080SH1 is selected as Lf (its size is 0603, as highlighted in Figure 2). Two 1206 100µF ceramic capacitors are still used as C2. The resonant frequency is 424kHz.

$$\frac{1}{2\pi\sqrt{L_f C1}} = 424\ \text{kHz} \qquad (4)$$

The noise measurement comparison is shown in Figure 3. At 2MHz switching frequency, the output switching ripple was 234µV without the LC and is greatly reduced to 15µV after adding a 0603 ferrite bead.

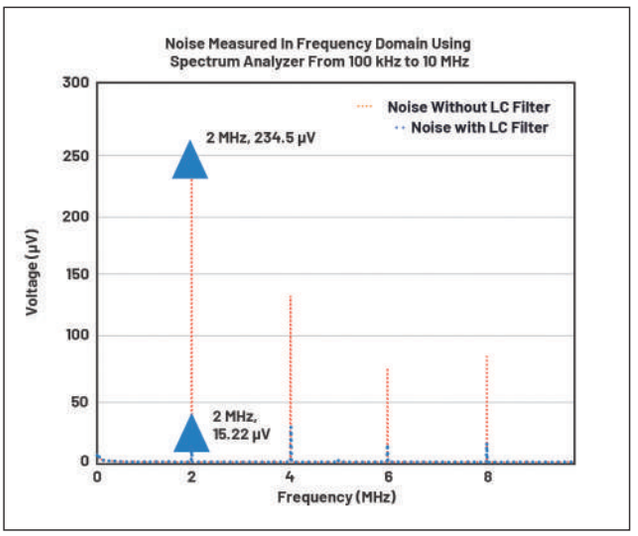


Figure 3. Switching noise without the LC (234µV) vs. with LC (15µV).

The addition of the second-order LC filter to minimise noise maintains the control loop bandwidth at 100kHz and fast transient response with recovery below 10µs, which is confirmed through bench evaluation with and without the LC filter. Recovering within 10µs allows a negligible blanking time, which is desired in wireless and RF applications. ADI's LTM4702 resolves the system designer's challenge of low signal processing efficiency caused by the load transient blanking period.

The load transient waveform shown in Figure 4 verifies fast transient response and recovery within 10µs after adding the second-order LC filter, similar to the behaviour of the design example without this filter.

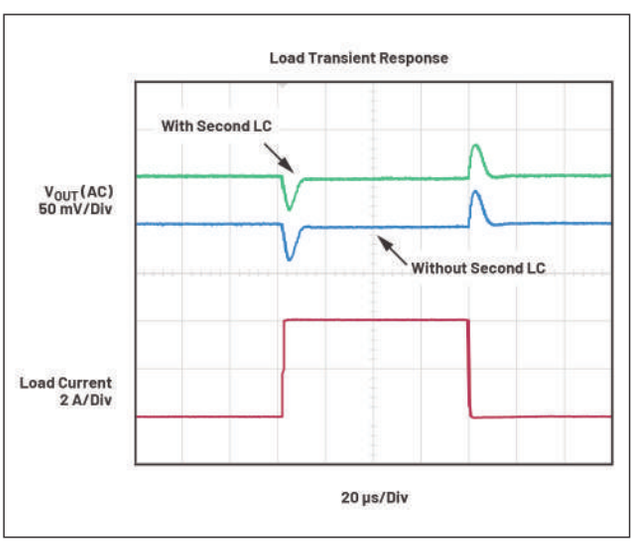


Figure 4. Load transient results: without LC vs. with LC (recover within 10µs).

Conclusion

Supporting high current applications with minimal noise while ensuring high efficiency and stability can be challenging. Adding a second-order LC filter can significantly reduce noise but may cause instability if not optimised correctly. To minimise noise without compromising stability, use an optimised second-order LC filter. By carefully selecting the required L and C components based on the switching frequency, control loop bandwidth, and resonant frequency, one can minimise the switching noise while maintaining a fast transient response and high bandwidth.

Analog Devices: www.analog.com

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Shrinking automotive audio system designs with Class-D amplifier 1L modulation

Mark Ritchey, Product Marketing Engineer at Texas Instruments

Sophisticated digital processing and analog semiconductors are helping audio designers create new ways to deliver an immersive audio experience to meet consumer demand for enhanced audio technologies – on portable speakers, laptops, sound bars and in automotive sound systems.

Today's automotive audio systems are far more sophisticated than the vacuum tube-powered amplifiers used in the very first single-speaker car radios. Some new car models have two dozen or more speakers throughout the vehicle. The progression from these first systems to the immersive, high-quality audio systems available today centers on four design trends that can deliver better audio in vehicles: size, weight, cost and audio quality. These trends are well-known across the automotive audio market. However, the real challenge is how to shrink a solution and its cost while maintaining quality audio performance.

Pushing audio amplifier designs further

For several years, automotive audio systems used Class-AB audio amplifiers to deliver sound to car speakers. In past years, there's been a trend to switch from Class-AB amplifiers to Class-D amplifiers. Class-D amps help designers achieve higher power efficiency, as well as reduced thermal dissipation and system weight targets.

Design engineers familiar with Class-D automotive amplifiers know that they require two inductor-capacitor (LC) filters per channel of audio to filter high-frequency switching noise. To shrink the size of the LC filters, TI developed audio amplifiers to support up to 2.1MHz switching, enabling the use of significantly smaller and cheaper inductors. Figure 1 compares this size evolution of the inductors from 400kHz to 2.1MHz.

Now, TI is taking the next step to further reduce LC filter size with an audio amplifier integrating our proprietary one-inductor (1L) modulation technology. This technology maintains Class-D performance, while cutting the number of inductors per channel by half, which leads to 50% less inductor cost and a solution up to 50% smaller and lighter. The end benefits include simplified audio designs and increased efficiency.

1L modulation technology in action

Our 1L modulation technology halves the inductor count in the LC filters. Now imagine a carmaker whose vehicle trim line includes a high-end model with a sound system that requires 32 audio channels. For every channel of audio, there is a speaker, and every speaker has two connectors: positive and negative. For an amplifier only supporting BD or one-sided pulse-width (1SPW) modulation, each lead requires an LC filter, totaling 64 inductors. With a 1L modulation amplifier, you only need one LC filter per channel of audio, reducing the number of inductors to 32.

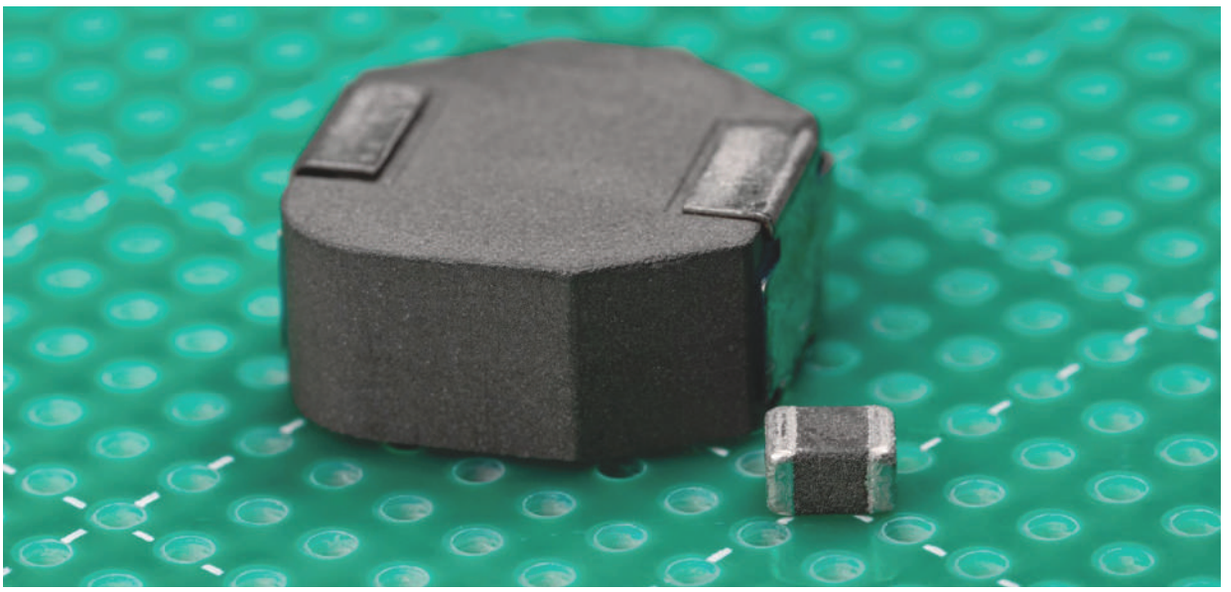

Figure 1 Size comparison of an 8.2µH inductor (400kHz) and a tiny 3.3µH inductor (2.1MHz)

Figure 2 demonstrates how amplifiers with 1L modulation reduce the number of inductors of a 20-channel audio system to 10 channels, resulting in a 34% size reduction.

An obvious concern for system architects would be how easy it is to implement this amplifier. Our 1L modulation technology is meant to incorporate into systems seamlessly. With 1L modulation, TI created a modulation scheme that fits into the amplifier in such a way that designers can reap all of the benefits without introducing significant design challenges, while still maintaining high-quality Class-D audio performance.

The TAS67524-Q1 audio amplifier incorporates features such as real-time load diagnostics, current sense per channel, and up to 19V operation for safe operation and higher performance. Real-time load diagnostics tracks the status of the load for open loads, shorted loads, shorts to power and shorts to ground, whether audio is playing or not. This feature ensures that the amplifier is functioning properly and provides a safe and reliable listening experience.

Another notable feature is the low-latency path option. If the system requires active noise cancellation or road noise cancellation, the TAS67524-Q1 enables fully-featured low-latency audio for quick response of the injected audio signal.

Conclusion

The benefits of our 1L modulation technology can help you create smaller and lighter designs more affordably than current solutions, all while prioritizing the automotive audio experience and still pushing the boundaries of your design.

Additional resources

- Order the TAS67524 evaluation module (TAS67524Q1EVM).
- Check out TI's full range of end-to-end audio solutions, including amplifiers, processors, converters and switches.

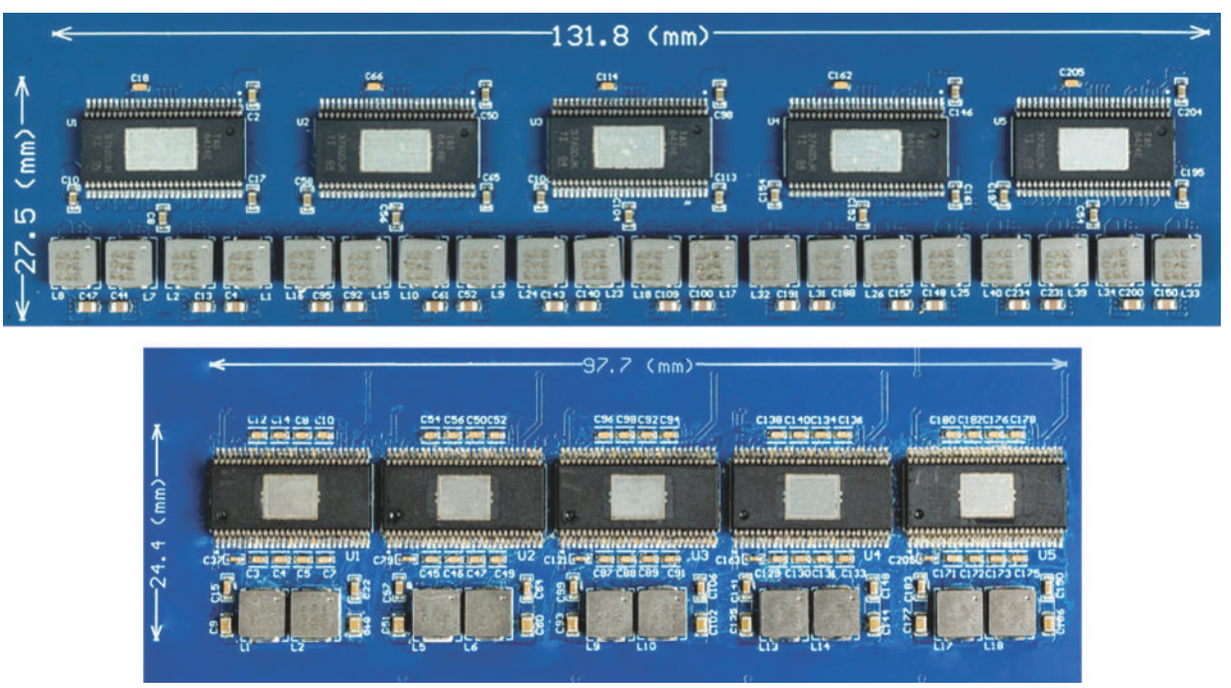

Figure 2 A 20-channel automotive audio system design featuring TI's TAS6424E-Q1 Class-D amplifiers (top) compared to TI's five TAS67524-Q1 Class-D amplifiers (bottom)

Switchgear shortage – mind the power gap!

Switchgear is fast becoming one of the biggest hidden constraints in UK commercial construction and yet it barely features in the wider debate about AI, net zero or infrastructure growth.

So says leading supplier Prism Power, who are seeing it daily - lead times once predictable now stretching into many months, plus manufacturers inundated with data centre orders so that commercial building projects (including offices, mixed use schemes, logistics hubs and healthcare facilities) are increasingly finding themselves pushed down the queue.

With data centres absorbing enormous volumes of low voltage and medium voltage switchgear, along with AI workloads, hyperscale cloud expansion and government backing of digital infrastructure, demand has raced into a different gear entirely.

Adhum Carter Wolde-Lule, Director at Prism Power Group, explains: "Manufacturers are simply behaving rationally. If you are allocating factory capacity and you have a 50MW data centre framework on one side and a standalone commercial building on the other, the decision is straightforward. Scale and certainty win.

"Commercial projects are now operating in a market where they are no longer the priority customer. We are seeing selective quoting, with some manufacturers choosing not to price lower value packages at all. Validity periods are shrinking. Deposits are increasing. High value or repeat projects are favoured, while one off commercial schemes struggle to secure firm commitments."

One of the biggest problems is that too many programmes are still built on outdated assumptions. Switchgear is no longer a late-stage procurement item that can be slotted in once the design is largely complete. It has become a critical path risk that requires early design freeze and early engagement with manufacturers. Leave it too late and commissioning windows collapse, temporary power arrangements become extended, redesign pressure increases and cost certainty evaporates.

More concerning is the compliance risk that creeps in when projects are under pressure. When timelines compress and options narrow, teams start looking for what is available rather than what is engineered correctly for the application. Substitutions become reactive. Approvals are rushed. Non-standard configurations enter the conversation. Electrical infrastructure is not decorative. It is the safety backbone of the building. You cannot value engineer resilience out of it without consequence.

There is also a broader market distortion taking place. When manufacturers prioritise only large repeat buyers - understandably drawn to the hyperscale data centre sector - SMEs and regional contractors are squeezed. They either price in significant risk premiums or decline to tender altogether.

Wolde-Lule adds: "We are already seeing fewer competitive bids on commercial electrical packages and higher contingency allowances built into pricing. That ultimately impacts developers, investors and occupiers.

"At the same time, the industry is transitioning towards new generation, SF6 free medium voltage equipment. Environmentally this is absolutely the right direction, but product transitions require engineering familiarity, requalification and in some cases redesign.

"When you combine surging digital infrastructure demand, wider electrification, technology transition and finite manufacturing capacity, you do not have a short-term spike. You have sustained structural pressure."

Prism Power is advising prospective clients to start treating switchgear as a strategic procurement item. That means early contractor involvement, earlier design freeze, earlier engagement with manufacturers and realistic lead time assumptions built into programmes from day one. Two stage procurement and long lead item strategies are no longer optional.

Government also has a role. If the UK is serious about accelerating housing delivery, commercial development, electrification and digital infrastructure, then domestic and European electrical manufacturing capacity must be recognised as part of national infrastructure resilience.

The uncomfortable truth is that AI is not slowing down and neither is electrification or data centre construction. Commercial construction is now competing in that same supply chain ecosystem. Unless programmes, procurement strategies and industrial policy evolve accordingly, commercial projects will continue to operate in a poor second place.

Wolde-Lule concludes: "At Prism Power, we are adapting. We are engaging much earlier, designing smarter and working closely with clients so we don't have bottlenecks. But this is bigger than any one contractor or supplier. If we want to build faster, safer and more reliably in the UK, we need to address the issue that rarely makes headlines. Switchgear may not be glamorous, but without it nothing turns on."

For further information visit: https://www.prismpower.co.uk/

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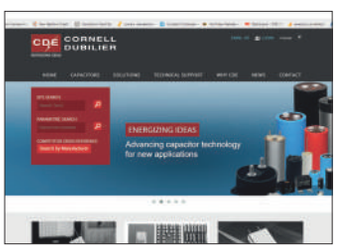

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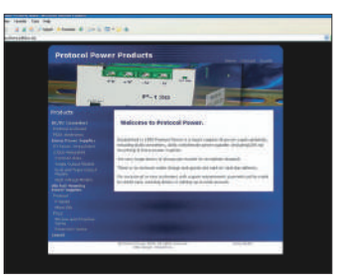

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