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**FEATURE STORY**

## Knightscope's autonomous security robots patrol with superhuman acuity and detection prowess

A fusion of innovative robotics, self-driving technology, vehicle electrification and artificial intelligence

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# Record numbers set for the PCIM Europe 2023

This year's PCIM Europe is recording record figures - both for the exhibition area and for the presentations at the conference. From 9 - 11 May 2023, the power electronics industry will be meeting in Nuremberg to exchange information on innovative products, the latest trends and current research results.



Two months before the start of the PCIM Europe, the exhibition area marks an historical peak with more than 30,000 m<sup>2</sup>. The companies represented there include industry leaders such as Fuji Electric Europe, Infineon, Mitsubishi Electric Europe, Semikron Danfoss, Wolfspeed, Nexperia, Rohm Semiconductor, Hitachi Europe and Texas Instruments Deutschland, 57% of which are international. An overview of all exhibiting companies can be found in the online exhibitor list.

The parallel conference presents a top-class program of around 400 presentations. The topics range from silicon and wide bandgap power semiconductors to innovative packaging technologies, e-mobility and renewable energy technologies.

For the first time, a poster session will also be held on the last day of the conference in the NCC Mitte entrance area to provide a platform for the many qualified submissions. The format is characterized by the exclusive 1:1 exchange between experts and the interested visitors.

## Focus topics of the exhibition create highlights

The three Stages provide the exclusive knowledge platforms of the exhibition for different focus topics.

As part of the E-Mobility & Energy Storage Zone, the same-named Stage offers specialist presentations for the application areas of electromobility and energy storage of power electronics. In addition, visitors can learn about

the specific products and services offered by a total of 27 companies, including Hitachi Energy Switzerland, Semikron Danfoss and Littelfuse, in live presentations directly at their stands.

On the Exhibitor Stage, interested parties can experience product innovations from exhibiting companies, such as Vincotech and Weidmüller Interface.

The Industry Stage is the platform for presentations and panel discussions on current research and development topics. Highlights of the agenda include the panel discussions on "Wide Bandgap Design with GaN HEMT and Vertical GaN", "SiC is Sold Out for 2023 - Can GaN Help Me?" as well as "Support for Grid Integration of E-Mobility Charging Infrastructure Using Energy Storage".

Another focus of this year's event is on the partner country, the USA. This region has a promising future in the field of power supply for IT and data centers. At the U.S. Pavilion, interested visitors can directly exchange ideas with the companies represented from the focus country.

## Experts to present first-time publications

The three special sessions at the conference will once again focus on particularly relevant industry topics: "Solutions for Future Medium Voltage Grids", "Power Electronics for E-Mobility" as well as "Understanding Losses in WBG Power Devices".

In addition to the special sessions, three keynotes are highlights of the conference:

- How Life Cycle Analyses are Influencing Power Electronics Converter Design", Franz Musil, Power Electronics Engineer at Fronius International
- On the Way to the DC Factory – The Open Industrial DC Grid for Sustainable Production Sites is Entering the Dissemination Phase", Holger Borchering, Scientific Director, University of Applied Sciences and Arts Ostwestfalen-Lippe
- HV Silicon and SiC Power Semiconductors; Key Components for Sustainable Energy Solutions", Munaf Rahimo, President and Founder, MTAL

Further information regarding the conference program can be found at [pcim-europe.com/program](https://pcim-europe.com/program).

## Hands-on seminars and tutorials

On the days leading up to the conference, participants can enter into direct exchange with renowned experts in small groups and obtain first-hand, practice-oriented know-how. Special topics such as "Power Electronics in Electric Vehicles", "Drives", "WBG Devices" and "Reliability" will be presented in 11 half-day seminars and 6 full-day tutorials at the Arvena Park Hotel, Nuremberg on 7 and 8 May 2023.

## Digital addition complements the PCIM Europe 2023

The "PCIM Europe digital" optimally complements the PCIM Europe on-site in Nuremberg with a digital platform. Participants can catch up on missed lectures or watch them again until 30 June 2023. Contributions include

- Live streaming of the conference presentations from Stage Brussels 1 in Nuremberg.
- Presentations from the three stages at the exhibition will be recorded on-site and be available afterwards on-demand. The conference presentations are also available on-demand.
- Exhibitors are represented on the digital platform with their company and product profiles.

Further information and tickets for the event can be found at [pcim-europe.com](https://pcim-europe.com).



# Further sustainability focus in power electronics

The entire power electronics industry and the manufacturers of various components are aware of the importance of using eco-friendly and sustainable materials. This important topic will also play a special role at this year's PCIM Europe from 9 – 11.5.2023 in Nuremberg, Germany.

On the way to becoming climate-neutral, sustainability can succeed when the energy transformation and the associated decarbonization are completed. In this context, power electronics plays an important part as a key technology in various sectors, since, among other things, the electrification of many applications is seen as a precondition for a climate-neutral transformation of the energy system.

All three keynotes at the PCIM Europe Conference will focus on power electronics innovations and trends in relation to sustainability. The keynote "How Life Cycle Analyses are Influencing Power Electronics Converter Design", presented by Franz Musil, Power Electronics Engineer at Fronius International, looks at the holistic evaluation of the environmental impact on a converter system through the use of a life cycle analysis. The keynote will explain this concept in detail using two examples: a PV inverter and a weld machine. The knowledge gained on the environmental impact will be used for product development and will form new performance

indicators in the evaluation of power electronic systems.

Holger Borchering, Scientific Director, University of Applied Sciences and Arts Ostwestfalen-Lippe will present the keynote talk entitled "On the Way to the DC Factory - The Open Industrial DC Grid for Sustainable Production Sites is Entering the Dissemination Phase" on the second day of the event. This session will focus on DC grids for industrial applications. DC grids promise higher energy efficiency, among other things due to the low losses during energy transfers as well as the elimination of AC/DC conversion that would otherwise be necessary. Correctly used DC grids in industrial plants can thus make a significant contribution to increasing energy efficiency and thus to sustainability in the future.

On the third and last day of the conference, Munaf Rahimo, President and Founder of MTAL, will present the keynote talk on "HV Silicon and SiC Power Semiconductors - Key Components for Sustainable Energy Solutions", focusing on high-power and high-voltage semiconductors and their major importance for industrial manufacturing and power grids. Unlike, for example, in electromobility where low-voltage semiconductors are used, power grids are expected to operate 24 hours a day for many years. "With the increasing use of renewable

energy sources and the generally increased need for electrical energy, the semiconductor industry is challenged to provide devices that are suitable for these applications," explains Drazen Dujic, Power Electronics Laboratory, EPFL.

All sessions of the conference will cover sustainable topics in which power electronics plays a key role - from renewable power generation to energy storage solutions and related energy efficiency to power electronics in e-mobility. The detailed conference program can be found at [pcim-europe.com/program](http://pcim-europe.com/program).

The exhibition also picks up on corresponding technologies and innovations. In addition to countless product innovations from the exhibiting companies in this field, the PCIM Europe also offers a focus on this topic with the E-Mobility & Energy Storage Zone. "E-mobility and energy storage represent essential components of a decarbonized and therefore a sustainable future," summarizes Frank Osterwald, Gesellschaft für Energie und Klimaschutz Schleswig-Holstein. Electromobility is driving new developments in power electronics, but it also raises many questions that need to be answered by new technological developments. At the PCIM Europe, the work of science and industry to clarify these open questions will be shown.

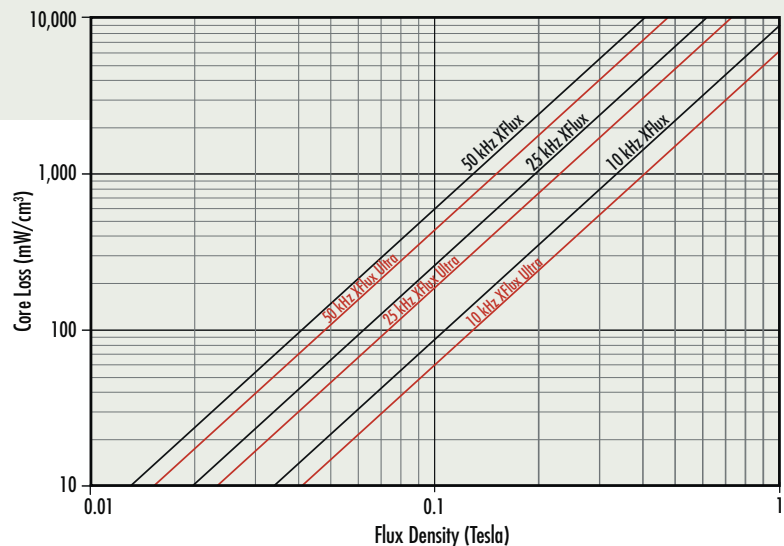


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# Ansyz Joins PowerizeD Research Initiative to Enable Sustainable and Resilient Energy Applications

Ansyz brings power of digital twins to European initiative that focuses on digitalisation of power electronics and decarbonisation



## Key Highlights

- *Ansyz joins leading organisations on the three-year, 72-million euro project to elevate the sustainability and resilience of the European energy chain via smart, efficient power electronics*
- *Ansyz will demonstrate how digital twin technology used as part of multiphysics workflows can increase efficiency, lower development costs, and contribute to decarbonisation efforts*

London, UK, April 11, 2023 – Ansys (NASDAQ: ANSS) joined European research initiative PowerizeD, which focuses on boosting the intelligence of power electronics to make them more efficient. As part of the initiative, Ansys will demonstrate the power of digital twins through new workflows that can increase efficiency, reduce development costs, and contribute to decarbonisation efforts.

The project, initiated and coordinated by long-time Ansys customer Infineon Technologies AG (Infineon), is expected to contribute to European decarbonisation and climate protection by improving the sustainability and resilience of the European energy chain.

Reliability issues in power electronics can often be traced back to thermal stress, which can be predicted and then mitigated via new compact digital twin workflows. These workflows are based on Ansys® Twin Builder™ and Ansys® optiSLang™, relying on metamodels built with Ansys® Fluent®, Ansys® Mechanical™, Ansys® Sherlock™, and Ansys® Electronics Desktop™. Using this approach with PowerizeD, Ansys will demonstrate how development time and costs can be saved by eliminating unnecessary prototypes and testing, while extending the useful life cycle of power electronics devices.

"We have to make highly efficient use of energy if we are to achieve net-zero climate protection goals. Digitalisation can help here as a highly decisive lever for more energy efficiency," said Constanze Hufenbecher, chief digital transformation officer at Infineon. "We are pleased to combine our strengths with the strengths of so many excellent partners from research and business to jointly make the ambitious European research initiative PowerizeD a success."

"Power electronics is key to energy transformation and is used anywhere and everywhere that electricity is generated, transferred, and used efficiently," said Dr. Rutger Wijburg, chief operations officer at Infineon. "The broad spectrum of power electronics applications makes it very important that we collaborate with partners across the boundaries of corporate entities and organisations to jointly advance Europe as an innovation engine."

The immediate PowerizeD project objectives include:

- *Reduction of power loss in power conversion by 25 percent*
- *Extension of the service lives of devices and systems by 30 percent*
- *Reduction of chip size by at least 10 percent*
- *Shortening development times by a challenging 50 percent*

"Ansys already works closely with many companies involved in the European Research Initiative PowerizeD to help optimise product development and integrate simulation into digitalisation efforts," said Shane Emswiler, senior vice president of products at Ansys. "We look forward to collaborating with the project's research partners on an interdisciplinary approach to power electronics that will demonstrate the value of an integrated simulation workflow and our compact digital twin technology."

## About PowerizeD

The project has been accepted for funding within the Key Digital Technologies Joint Undertaking (KDT JU), a public-private partnership in collaboration with the Horizon Europe (HORIZON Framework Program and National Authorities under grant agreement number 101096387 Co-funded by European Union). Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union or Horizon Europe. Neither the European Union nor the granting authority can be held responsible for them.

Further information on the project and the project partners can be found at the following web site: [www.powerized.eu](http://www.powerized.eu)



# Digi-Key Launches Supply Chain Transformed Season 2 Video Series

Second season explores building flexible, agile and resilient supply chains

THIEF RIVER FALLS, Minnesota, USA - Digi-Key Electronics, which offers the world's largest selection of electronic components and automation products in stock for immediate shipment, has released the first episode in Season 2 of its "Supply Chain Transformed" video series focused on advancements in IoT, connectivity, sensors and asset tracking within the supply chain.

Sponsored by Nordic Semiconductor, the three-episode series will take a closer look at how the world is tackling new and ever-present challenges in global logistics and explore how technology is poised to provide visibility and insight into supply chain risks.

Digi-Key introduced Season 2 of its Supply Chain Transformed video series with Nordic Semiconductor.

"Recent years have shown how much risk truly exists between point A and B in the supply chain," said Josh Mickolio, supplier business development manager for wireless and IoT at Digi-Key. "With so much continued focus on global logistics, it's more important than ever for accessible, automated monitoring and tracking. At Digi-Key, we're dedicated to ensuring that the most in-demand products are readily available to the engineers and designers that depend on them."

"Automation is key to being able to scale and optimize global supply chains," said Magnus Pedersen, vice president of sales, EMEA at Nordic Semiconductor. "The more efficient we can make the supply chain, the better it is. Fewer parts will have to be in temporary storage and the delivery precision for customers increases. This should save time and money, all the way from wafer production until the end customer receives their end product."

The first of three videos in the series, "The Path to Recovery," is now live on Digi-Key's website, and delves into how supply chains have evolved since the events of 2020 and what suppliers are doing differently to ensure that the most in-demand products are readily available to engineers and designers that depend on them.

The second video, entitled "The Beginning of the Supply Chain," will look at how suppliers source raw materials and

components that form the building blocks of today's modern designs; and the third video, "Future-Proof Supply Chains," will explore the steps needed to ensure future supply chains are ready to meet the unexpected surges in demand.

Digi-Key Supply Chain Solutions & Services offer strategic procurement solutions to improve efficiency and avoid supply chain issues. To learn more about the video series and how Digi-Key is working to tackle global logistics challenges, visit the Digi-Key website.

## About Digi-Key Electronics

Digi-Key Electronics, headquartered in Thief River Falls, Minn., USA, is recognized as both the leader and continuous innovator in the high service distribution of electronic components and automation products worldwide. As the original pioneer in this space, Digi-Key provides more than 13.4 million components from over 2,300 quality name-brand manufacturers with an industry-leading breadth and depth of product in stock and available for immediate shipment. Beyond the products that drive technology innovation, Digi-Key also supports design engineers and procurement professionals with a wealth of digital solutions and tools to make their jobs more efficient. Additional information can be found at [digikey.com](https://www.digikey.com) and on Facebook, Twitter, YouTube, Instagram and LinkedIn.

## About Nordic Semiconductor

Nordic Semiconductor is a Norwegian fabless semiconductor company specializing in wireless communication technology that powers the Internet of Things (IoT). Nordic was established in 1983 and has more than 1300 employees across the globe. Our award-winning Bluetooth Low Energy solutions pioneered ultra-low power wireless, making us the global market leader. Our technology range was later supplemented by ANT+, Thread and Zigbee, and in 2018 we launched our low power, compact LTE-M/NB-IoT cellular IoT solutions to extend the penetration of the IoT. The Nordic portfolio was further complemented by Wi-Fi technology in 2021.

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# EPC agreement expands Anglia GaN portfolio

Addition of eGaN® technology strengthens distributors range of power technologies

Wisbech, 20 March 2023 Anglia Components PLC has significantly expanded its portfolio of power solutions following the signing of a distribution agreement for the UK and Ireland with EPC (Efficient Power Conversion), a leading provider of gallium nitride (GaN)-based power management technology.

Anglia offers its customers a full portfolio of the mainstream power technologies, including Silicon MOSFET and Silicon Carbide, and GaN, allowing them to select the solution that is most appropriate to their design from a size, efficiency, and cost perspective. The addition of EPC enhancement mode gallium nitride (eGaN) FETs and ICs strengthens Anglia's range particularly in the low voltage (sub-400V) end of the market. In many applications, EPC eGaN devices deliver lower system cost, higher performance and greater power density.

John Bowman, Marketing Director of Anglia, explained, "Power is attracting considerable focus from our customers at the moment. Their concern is driven both by environmental and economic considerations. EPC impressed us as a company that is pro-active in its approach to the market, anticipating customers questions about adopting this technology and helping them on the design journey to a smaller, more efficient system design. Our

F&E team is benefitting from this approach as they undergo comprehensive and in-depth training on the range."

Stefan Werkstetter, vice president Sales EMEA at EPC added, "We believe in developing relationships with channel partners with strong local expertise and wide and deep customer relationships in their region. Anglia fits that mould perfectly, with an exceptional F&E team and great traction in the UK and Ireland market. Our eGaN technology is widely applicable in industrial applications, including DC-DC converters, motor drive, medical, wireless power, server, 5G, solar, class-D audio and general comms infrastructure designs, all areas where Anglia is strong. We believe that they will be very successful in collaborating with customers to ensure that they achieve the potential that eGaN technology can offer."

## About EPC

EPC is the leader in enhancement mode gallium nitride (eGaN®) based power management. eGaN FETs and integrated circuits provide performance many times greater than the best silicon power MOSFETs in applications such as DC-DC converters, remote sensing technology (lidar), motor drives for eMobility, robotics, and drones, and low-cost satellites.

eGaN is a registered trademark of Efficient Power Conversion Corporation, Inc.

## About Anglia

Anglia Components plc is the UK's leading independent authorised distributor of semiconductors, optoelectronics, interconnect, passive and electromechanical components. A signatory of the ADS SC21 programme, the company holds AS9120, ISO9001 and ISO14001 accreditations.

Technically adept, with an experienced team of staff, Anglia supports OEM and EMS companies in every sector of electronics manufacturing. Anglia's suppliers include many of the world's leading electronic component brands, complemented by many smaller companies with leadership in their chosen technologies.

Anglia stocks over 2 billion components from over 1.3 million product lines in the UK. Components from every supplier are stocked in depth and breadth for same-day dispatch. Anglia aims to streamline logistics and reduce customers' transaction costs through services that include VMI, KAN-BAN, API, EDI, BoM management tools and customer-dedicated inventory, while an accurate, on-time delivery performance is a vital goal for the company.

Technical support spans a sampling service that delivers over £150,000 worth of free components and evaluation tools each year and expert technical advice from well-trained product specialists and face-to-face guidance from field applications engineers. Both commercially and technically, management of industry legislation and component obsolescence are recognised as areas of vital importance to customers.

Anglia is driven by an ethos of ever-improving customer understanding and, as a privately owned business, aims to provide a fast, consistent and highly responsive service. Further information can be found at [www.anglia.com](http://www.anglia.com) or [www.epc-co.com](http://www.epc-co.com)



From left to right: David Pearson, Technical Director, Anglia; Alex Lidow, CEO, Efficient Power Conversion; John Bowman, Marketing Director, Anglia.



# Restructuring of iC-Haus GmbH Management

iC-Haus appoints Dr. Alexander Flocke as further managing director alongside Dr. Heiner Flocke. Long-standing technical managing director Manfred Herz takes over the department "Advanced Technology Development" for tomorrow's chip innovations.

Bodenheim, Germany, March, 2023: At the beginning of this year, iC-Haus GmbH undergone some changes in its management to ensure the lived continuity and a sustained growth with new products and markets in the future. With the "iC" as a trademark, the medium-sized iC-Haus GmbH with its 370 employees and its vertical range of manufacture at the Bodenheim site near Mainz has won a leading position as a manufacturer of application and customer-specific integrated circuits and microsystems for industrial, automotive and medical technology, represented worldwide.

As of January 01, 2023, long-standing technical managing director and co-partner Manfred Herz stands down as managing director. He takes over the Advanced Technology Development in close cooperation with the development department to provide creative solutions and circuit innovations for chip design.

Representing Dr. Heiner Flocke as majority owner and managing director with his sole power of representation is Dr. Alexander Flocke, who has been appointed further managing director of iC-Haus GmbH as of January 01, 2023. Together with an authorized signatory, he has decision-making power and act as deputy of Dr. Heiner Flocke. Alexander Flocke holds a PhD in electrical engineering from RWTH Aachen University. He has been working at iC-Haus since 2008, first in Chip Development and now in Applications and Sales. Henrik Liungman joined iC-Haus in 2019 in Sales. Responsible for commercial aspects, he serves as authorized signatory.

Dr. Alexander Flocke



# Infineon acquires GaN Systems for \$380m

The two companies signed a definitive agreement under which Infineon will acquire GaN Systems for US\$830 million. GaN Systems is based in Ottawa, Canada and specialises in the development of GaN-based solutions for power conversion.

Infineon's CEO, Jochen Hanebeck, said the acquisition will accelerate the company's GaN roadmap and will strengthen the company's position in the power systems market.

"GaN technology is paving the way for more energy-efficient and CO2-saving solutions that support decarbonisation," he said. "Adoption in applications like mobile charging, data centre power supplies, residential solar inverters, and onboard chargers for electric vehicles is at the tipping point, leading to a dynamic market growth".

Jim Witham, CEO of GaN Systems (pictured), said: "The GaN Systems team is excited about teaming up with Infineon to create highly differentiating customer offerings, based on bringing together complementary strengths. . . . we will optimally leverage the potential of GaN.

GaN Systems' foundry partnerships and Infineon's in-house manufacturing capacity will enable maximum growth capability, said Witham. "I am very proud of what GaN Systems has accomplished so far and cannot wait to help write the next chapter together with Infineon," he says. "As an integrated device manufacturer with a broad technology capability, Infineon enables us to unleash our full potential."

GaN offers customers value by higher power density, higher efficiency, and size reductions, especially at higher switching frequencies. These properties enable energy savings and smaller form factors.

Market analysts expect GaN revenue for power applications to grow by 56% CAGR by 2027, to approximately US\$2bn (source: Yole, Compound Semiconductor Market Monitor-Module I Q4 2022) for a wide range of applications.

GaN is one of the key materials for power semiconductors, together

with silicon and SiC (silicon carbide). Last year, Infineon invested more than €2bn in a front end fab in Kulim, Malaysia which will operate in addition to Infineon's existing wide bandgap manufacturing capabilities in Villach, Austria.



Infineon's CEO,  
Jochen Hanebeck

# ASFETs for hotswap are packaged in copper clip LFPAK88

The 80V and 100V ASFETs for hotswap are in a compact LFPAK88 package measuring 8.0 x 8.0mm and have an enhanced safe operating area (SOA), says the company. The ASFETs are optimised for demanding hotswap and soft-start applications. They are qualified to 175°C for use in advanced telecomms and computing equipment.

Until now, ASFETs for hotswap and computing applications were limited to much bigger D2PAK packages (16 x 10 mm). LFPAK88 packages are the ideal replacement for D2PAK, providing up to 60% space efficiency, says the company.

The PSMN2R3-100SSE (100V, 2.3mΩ N-channel ASFET) delivers low RDS(on) to meet the requirements of demanding hotswap applications. Their second release is the PSMN1R9-100SSE (80V, 1.9mΩ), an 80V ASFET which has been developed for 48V power rails in computing servers and other industrial applications where environmental conditions allow for MOSFETs with a lower BVDS rating.

A third ASFET, the PSMN2R3-100SSE has an RDS(on) of only 2.3mΩ, representing at least a 40% reduction on currently available devices. This improves power density improvements by a factor of 58 and the LFPAK88 offers two times higher ID (max) current rating together with low thermal and electrical resistance.

ASFETs with enhanced SOA have a strong linear mode performance to manage in-rush current effectively when capacitive loads are introduced to the live backplane. Low RDS(on) is also important to minimise I<sup>2</sup>R losses when the ASFET is fully turned on, adds Nexperia. This is the company's third generation of enhanced SOA technology also achieves 10% SOA improvement compared to previous generations in D2PAK packages (33A vs 30A at 50V at 1ms).



The ASFETs have characterised SOA at both 25°C and 125°C. Fully tested, hot SOA curves are provided in the datasheets so design engineers do not have to perform thermal de-rating calculations. This also significantly extends the useful hot SOA performance, says the company.

Nexperia also offers a range of 25V, 30V, 80V and 100V ASFETs in a 5.0 x 6.0mm LFPAK56E package, optimised for lower power applications where a smaller PCB footprint is needed.

**Visit Nexperia at PCIM Europe: Hall 9-317**

## ePower stage ICs integrate a half-bridge power stage



The two 100V power stage ICs are the EPC23104, rated at 15A and the EPC23103, rated at 25A join the EPC23102 (100V, 35A) power stage IC.

All three ICs can withstand a maximum voltage of 100V and integrate a complete GaN half-bridge power stage that includes symmetrical FETs in half bridge configuration, half bridge driver, level shifter, bootstrap charging, and input logic interface.

They are supplied in a thermally enhanced QFN package measuring 3.5 x 5.0mm and which has exposed top for dual side cooling and wettable flanks. Footprint compatibility enables customers to upgrade a design for better performance or lower cost without modi-

fication to the board, says EPC, to adapt to changing load requirements.

In DC/DC applications, the devices can operate with high efficiency at high switching frequencies (3MHz maximum) and offer higher performance and smaller solution size for 28 to 60V DC/DC in computing, industrial and USB PD 3.1 applications.

In 32 to 48V BLDC motor drives for e-mobility, robotics, power tools and drones, the IC can operate with small deadtimes (21ns) and at 100kHz to increase the system efficiency due to less motor core losses and vibrations, and to reduce or eliminate the electrolytic capacitors.

"The ePower family of products makes it easy for designers to take advantage of the significant performance improvements made possible with GaN technology," says Alex Lidow, CEO and co-founder of EPC. "Integrated devices are easier to design, easier to layout, easier to assemble, save space on the PCB, and increase efficiency," he adds. In addition, these devices can reduce the weight or increase precision in BLDC motor drives, higher efficiency 48V input DC/DC converters, higher fidelity Class-D audio systems, and other industrial and consumer applications, says Lidow.

Two development boards, the EPC90151 and EPC90152, are half bridge demo boards featuring the EPC23103 and the EPC23104 ePower Stage ICs, respectively. The boards measure 50.8 x 50.8mm and contain all critical components for easy evaluation.

The EPC23103 and EPC23104, together with the development boards (EPC90151 and EPC90152) are available for immediate delivery from Digi-Key.

**Visit EPC at PCIM Europe 2023 : Hall 9-318**



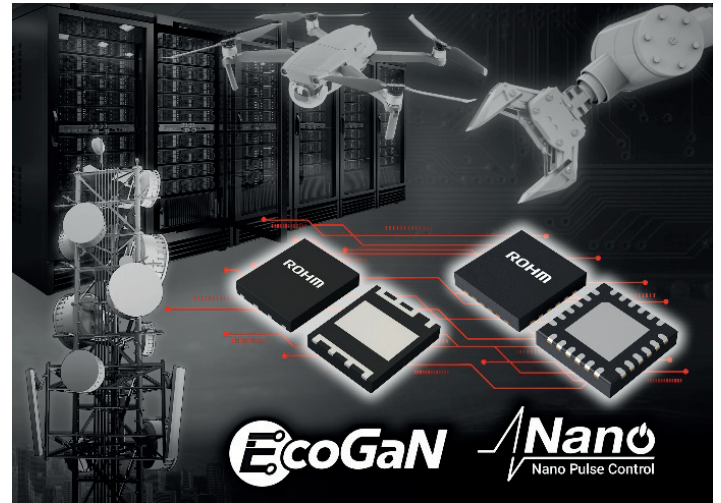
# High speed control IC technology is optimised for GaN devices

The company has evolved its Nano Pulse Control, high speed pulse control technology to improve control pulse width from nine nanoseconds to what it claims is an industry best of two nanoseconds. This technology has been developed to meet the high speed switching characteristics of GaN devices.

Many design engineers are investigating miniaturisation of the power supply circuit which requires a reduction in size of the peripheral components through high speed switching. Achieving this requires a control IC that can take advantage of the drive performance of high speed switching devices.

The company introduced high speed control IC technology for GaN devices using proprietary analogue power supply technology Nano Pulse Control. It plans to ship samples of 100V one-channel DC/DC control ICs in the second half of 2023. Using these ICs in conjunction with Rohm's EcoGaN devices is expected to result in significant energy savings and miniaturisation opening up design opportunities in a wide range of applications, including base stations, data centres, factory automation equipment and drones.

Nano Pulse Control in the ICs combines analogue circuit design, processes and layout to reduce the minimum control pulse width of the control IC. The circuit configuration allows the IC to step down from 60V to 0.6V with a single power supply IC in 24V and 48V applications. Support for smaller drive peripheral components for high frequency switching of GaN devices decreases mounting



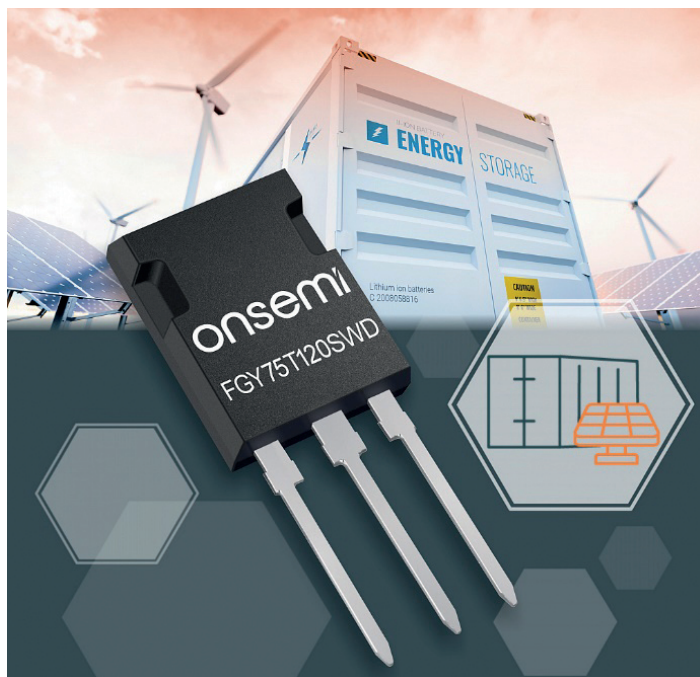
area by approximately 86% over conventional solutions when paired with an EcoGaN power supply circuit, reports the company and using a single IC instead of the conventional two power supply ICs.

**Visit Rohm at PCIM Europe 2023 - Hall 9 - 310**

# IGBT FS7 switches target energy infrastructure

The 1200V trench Field Stop VII (FS7) IGBTs will be primarily used in energy infrastructure applications like solar inverters, uninterruptible power supplies (UPS), energy storage and EV charging power conversion.

The IGBTs are used to boost input to high voltage (boost stage) as well



as the inverter to provide an AC output in high switching frequency energy infrastructure applications. The low switching losses of FS7 devices enable higher switching frequencies that reduce the size of magnetic components, increasing power density and reducing system cost. For high power energy infrastructure applications, the positive temperature co-efficient of FS7 devices enables easy parallel operation, says onsemi.

Efficiency is critical in high switching frequency energy infrastructure applications, explains Asif Jakwani, senior vice president and general manager of the advanced power division, at onsemi.

The FS7 devices include high-speed (S-series) and medium-speed (R-series) options. All include an optimised diode for low VF, tuned switching softness and can operate with junction temperatures up to 175°C.

The S-series devices, which include the FGY75T120SWD, offer the best switching performance among currently available 1200V IGBTs in the market, says onsemi. Tested with currents up to seven times the rated value, the rugged IGBTs also offer best-in-class latch-up immunity, claims the company.

The R-Series is optimised for medium speed switching applications, such as motor control and solid-state relay in which conduction losses are dominant occurs. The FGY100T120RWD, for example, shows a VCESAT as low as 1.45V at 100A, an improvement of 0.4V over previous generation devices.

The FS7 devices are available in a range of package styles including TO247-3L, TO247-4L, Power TO247-3L and as bare die.

**Visit onsemi at PCIM Europe 2023: Hall 9-330**

# MOSFETs reduce synchronous rectification losses

The N-channel power MOSFETs are specifically designed for use in high performance switching power supplies in industrial applications and base stations.

They are characterised by a maximum VDSS rating of 150V and current handling of 64A. The MOSFETs have low drain-source RDS (on) of just 9.0mΩ (max). This is over 40% less than is possible with the TPH1500CNH1 MOSFET, the previous generation device.

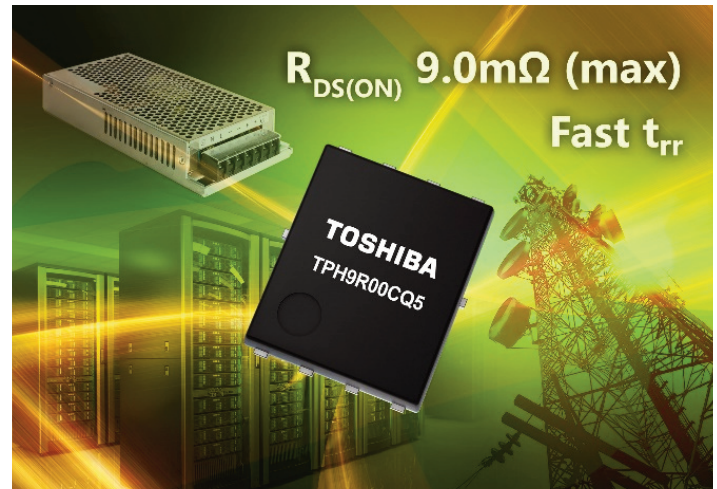
For high performance power devices using synchronous rectification, reverse recovery performance is highly important, Toshiba advises. The TPH9R00CQ5 MOSFET includes a high speed body diode which reduces the reverse recovery charge (Qrr) by around 74% (to 34nC typical) when compared to an existing device such as the TPH9R00CQH. The reverse recovery time (trr) is just 40ns which is an improvement of over 40% compared with earlier devices, reports the company.

Gate charge (Qg) is just 44nC, further contributing to reduced losses and increased power density. Unusually for a MOSFET, the channel temperature is 175°C (max) which, combined with the high speed diode will offer the designer increased thermal headroom.

The MOSFET also reduces spike voltages created during switching, thereby improving EMI characteristics of designs and reducing the need for filtering.

The TPH9R00CQ5 is housed in a surface-mount SOP Advance(N) package measuring just 4.9 x 6.1 x 1.0mm.

Toshiba has also developed a G0 SPICE model for rapid verification of the circuit function. There are also G2 SPICE models for accurate



reproduction of transient characteristics.

In addition, there are reference designs, including a 1kW non isolated, buck-boost DC/DC converter, a three-phase multi-level MOSFET-based inverter and a 1kW full bridge DC/DC converter, all of which use the TPH9R00CQ5.

The TPH9R00CQ5 MOSFET is shipping now.

**Visit Toshiba Electronics Europe at PCIM Europe 2023 – Hall 9 - 503**

## Rutronik expands automotive portfolio with Kyocera AVX supercapacitors

Kyocera AVX has expanded its SCC series to include six automotive-certified supercapacitors. The cylindrical SCC automotive grade supercapacitors were tested against the requirements of AEC-Q200 std and operate in both mechanically and electrically challenging conditions, said the company, whether in electronic-mechanical locking (e-latch), emergency call systems (e-Call), electronic recording (e-video), regenerative braking, power, and emergency power systems.

The automotive-grade supercapacitors have a very low ESR value, high capacitance and "excellent" pulse power handling characteristics. The capacitors meet UL 810A, RoHS and REACH requirements.

They are available in 25F / 2.7V, 100F / 2.7V, 10F / 3V, 35F / 3V, 50F / 3 as well as 100F / 3V.

To extend back-up times and battery life and to take advantage of instantaneous pulse power, the supercapacitors can be used alone or in conjunction with primary or secondary batteries.



**Visit Rutronik at PCIM Europe 2023 – Hall 6 - 322**

## Vishay offers anti-surge thick film power resistor in 0805 case size

Vishay Intertechnology has enhanced the Vishay Draloric RCS0805 e3 anti-surge thick film resistor in the 0805 case size with a higher power rating of 0.5 W.



It can now be used in place of four standard parallel resistors in the 0805 case size or in place of two parallel devices in the larger 1206 case size or one resistor in the 1210 case size. Designers can save board space in automotive, industrial, telecommunications and medical applications while lowering component counts and reducing placement costs. For applications subject to high and repetitive surge pulses, the resistor also offers superior pulse load performance and ESD surge characteristics when compared to standard chip resistors, says the company.

The AEC-Q200-qualified RCS0805 e3 features a resistance range from 1.0Ω to 10MΩ (and 0Ω jumper) with tolerances of ± 0.5%, ± 1% and ± 5%. TCR is ± 100ppm/K and ± 200ppm/K.

The resistor offers an operating voltage of 150V and an operating temperature range of -55 to 155°C. They are RoHS-compliant and halogen-free, and therefore suitable for processing on automatic assembly systems as well as for wave, reflow, or vapor phase soldering per IEC 61760-1.

Samples of the enhanced RCS0805 e3 are available now, with lead times of 12 weeks.

**Visit Vishay at PCIM Europe 2023 – Hall 9 – 210**



# Board mount DC/DC converter series is for railway applications

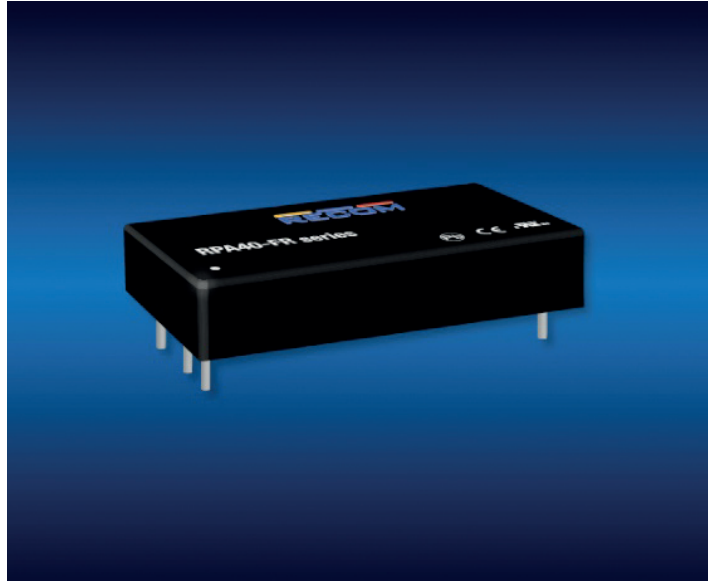
Models in the regulated and isolated RPA40-FR series feature a 36 to 160V input range (200V/1 sec) which includes rail nominals of 72, 96 and 110V with surges and dips. Low noise, single and dual output models available are 5.0, 5.1, 12, 15, 24,  $\pm 12$  and  $\pm 15$ V with the single outputs' trimmable minimum  $\pm 10\%$ . The 15 and 24V models are trimmable to 20/-10%. No minimum load is required.

According to Recom, the DC/DC converters set a standard for power density and cost-effectiveness with 40W output in an industry-standard board-mount through-pin package and a form factor of 50.8 x 25.4 x 10.2mm (2.0 x 1.0 x 0.4 inches).

The efficiency of the RPA40-FR series peaks at 90%. This performance is coupled with a thermal design which allows operation with natural convection to high temperatures without derating up to 105°C ambient with reduced load and/or airflow. Safety features are over-temperature, input under-voltage, output over-current, and short circuit protection. A control pin is also provided to shut down the DC/DCs into a low dissipation state.

The DC/DC converters are designed to multiple safety certifications, which include UL/EN/IEC 62368-1, EN 45545-2 and EN 50155, with a reinforced isolation rating of 3kVAC/1 min. The converters meet EMC specification EN 55032 class A without external components and class B can be met with a simple external filter network.

The DC/DC converters are reliable with a MTBF of 1.25Mhrs at 25°C according to MIL-HDBK 217-F (GB). These characteristics make the rugged, encapsulated RPA40-FR DC/DC converters suitable for harsh rail



environments as well as for general industrial use.

The parts are covered by a three-year warranty. Samples and OEM pricing are available from all authorised distributors or directly from Recom.

**Visit Recom at PCIM Europe 2023: Hall 6-452**

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# Knightscope's autonomous security robots patrol with superhuman acuity and detection prowess

A fusion of innovative robotics, self-driving technology, vehicle electrification and artificial intelligence

The concept of automated policing began as a science-fiction concept years ago, but today it is real and impactful. The sophistication of robot-powered security is actually even more interesting if you spend a few minutes talking to Stacy Stephens, the co-founder and chief client officer of Knightscope, Inc.

Launched in 2013, the Mountain View, CA, public safety technology services company was the first in the world to deploy mobile, fully autonomous security robots (ASRs) in public spaces such as malls, parking lots and neighborhood parks. The Knightscope vision was to find a more effective means of deterring crime while minimizing risk to law enforcement officers.

Describing Knightscope as a leading public safety tech company, rather than a robotics organization, Stephens said their expertise includes a fusion of robotics, self-driving technology, vehicle electrification and artificial intelligence. Combined, they yield an agile platform upon which numerous types of sensing capabilities and other technologies can be integrated to provide actionable intelligence.

## Next-generation of ASR surveillance capability

Knightscope ASRs have a wide array of features and capabilities. These include a 360-degree 4K video system, two-way audio, license plate recognition, thermal imaging, people detection, facial recognition and signal detection for mobile devices.

ASRs are equipped to scan for known threats, allowing companies to reduce workplace violence by providing facial recognition capabilities and parking lot security by using exception monitoring to ID the license plates of cars that don't belong on site.

With their audio feature, ASRs provide two-way communication, giving the robots

broadcast capability that allows them to engage with the surrounding environment. This permits first responders to de-escalate hostile situations by putting a robot in place of a person.

"The ASR's 'talk-down' feature takes the danger off the human and puts it on the robot," Stephens said. "Robots are a nondescript object that allow a conversation to take place without having a person in front of a hostile suspect that could unintentionally escalate the situation."

ASRs also can be used as a public address system in the event a building must be quickly evacuated. In addition to spotting bad actors, the ASR's facial recognition feature is used by one casino to identify VIPs, who are now greeted before they even enter the building.

As Stephens points out, ASRs take on boring, routine and monotonous activities that free up security personnel for more

hands-on, strategic or customer service-related activities. And they reduce the likelihood of injury and death for both public safety professionals and perpetrators.

"They also lower operating overhead," Stephens said. "ASRs never get sick, and they don't take vacations."

## Infusing technology to drive ASR autonomy

All of Knightscope's mobile robots are completely autonomous, using a system of LIDAR, GPS, sonar, IMUs, 4K cameras and high-fidelity audio. Just as people have five senses, the robot has five sensor types to manage its surroundings. And in nearly every instance, the robot's senses are more acute than a public safety officers.

The first of these, situated on top of the robot, is the LIDAR. This includes a series of lasers with another set positioned at eye-level, along the robot's waistline, on



Knightscope's mobile robots are completely autonomous, using a system of LIDAR, GPS, sonar, IMUs, 4K cameras and high-fidelity audio. The robot has five sensor types—similar to humans but with far greater acuity.





**Knightscope ASR can patrol indoors and out with incredible dexterity because of the many highly-refined sensors. Together, the five sensor modalities paint an incredibly accurate picture of the robot's geofenced environment and allow the ASR to successfully navigate complex environments while avoiding people, animals and objects.**

the backside and two more along the skirt. In all, 21 lasers map the surrounding area every 25 milliseconds. That data is used to create a 3D map of the area around the robot out to a 100-meter radius, which enables the ASR to "see" its environment.

Secondly, sonar sensors are located around the robot to provide proximity sensing that allows the robot to tell when something is physically close. This allows the ASR to take evasive action or communicate with an approaching person. GPS is included as a tertiary input for internal navigation and helps track the machine in the event that someone were to attempt to move or steal the robot.

Odometry sensors calculate wheel rotation to indicate if the robot is moving or tracking left or right. And finally, an inertial measurement unit, or IMU, provides six-degrees-of-freedom spatial awareness to determine if the robot is upright or tilted, which could signal it has become stuck or immobilized.

Together, the five sensor modalities paint an incredibly accurate picture of the robot's geofenced environment and allow the ASR to successfully navigate complex environments while avoiding people, animals and objects.

#### **AI and edge computing process data at lightning speeds**

The ASR architecture is built so that the data is constantly streamed and recorded.

That creates about 90 terabytes of data per robot per year, which no human could process. Data is stored for up to 30 days, which is the typical security industry standard for data retention.

Data is stored both on the robot and in the cloud, depending on the situation. The difference between the two sets of data is associated with the threat level. If a threat is detected, the data is simultaneously sent to the cloud and triggers an alert. If the robot is just recording video as it patrols the park, then immediate access to the cloud is not necessary and the data is stored on a local hard drive.

Artificial intelligence is used on the navigation stack and to analyze different parts of the video stream. For example, AI is used for people detection and to enable facial recognition systems to determine the similarity ratio of a detected face versus one in the user-generated database. That could be used, for example, to look for a lost child at a park or festival grounds. AI is also used for license plate recognition, especially because the 50 U.S. states have so many different kinds of plates, personalized and otherwise.

#### **Power efficiency is paramount to ASRs**

The intense level of computing, communications, and sensing places a tremendous burden on the ASRs' power delivery networks (PDN). The PDN must

be compact and have high efficiency. Because the ASRs have no airflow or venting, Knightscope went hunting for a pure conduction-cooled solution that could use the aluminum skin as a heat sink. The company adopted a Vicor DC-DC converter module (DCM3623) because its unique ChiP™ (Converter housed in Package) design was thermally adept and very small. The high DCM™ power density also helped with routing the wiring and cable assembly and increased battery efficiency, performance and runtime.

As Stephens explained, "Unlike an electric car, the goal is not to maximize range. It's more about maximizing robot run-time and minimizing the charge time, because it operates 24/7/365."

On the electrical side, the robot required isolation from all of the different power rails. Because there are so many sensors with different EMI signatures, the Vicor DCM helped minimize EMI and noise interference.

Knightscope has a long roadmap of features and capabilities that can be added to the robots. In this case, Vicor DCMs provide a scalable platform and uniform height that obviates the need to change the heat sinking or mechanical components.

"The more we're able to reduce the burden on the battery, the longer run-time we will get," Stephens said. "So, power's always, always going to be a



Knightscope's robots can be seen

acute capabilities. Its unwavering attention to detail, rapid recognition, recall and ever-vigilant commitment to duty is an unmatched approach to safety and security. It appears there is a new sheriff in town, and the name is Knightscope.

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POWER ELECTRONICS EUROPE



# The Pressure is On

John Govier, Sales Director of Inseto, summarises how far sintering has come and hints at what's in store.

The EV sector is constantly striving for higher power densities (in terms of  $W/m^3$ ) and in particular with regards to the electronics for controlling power, both within vehicles and within charging stations. Reducing the volume of a component reduces the quantity of materials to build it, thus reducing production costs.

Power modules, as used in inverters for example, are required to switch high voltages at high frequencies into loads that draw hundreds of Amperes. These requirements have made silicon carbide (SiC) the semiconductor material-of-choice, and EV power modules typically contain several SiC-based MOSFETs or IGBTs.

In addition to the requirements to switch more power, there is also a need for deep power cycling and providing high reliability operation in relatively harsh

environments. All of these factors place challenges on device packaging - certainly if industry is to get the most from all that SiC has to offer.

Although SiC devices boast low power losses these are relative to very high (achievable) power densities. Essentially, SiC-based high power switching structures run hot, and the heat must be dissipated. Moreover, SiC-based die can run far hotter than the melting point of even specialist solders.

## Sintering – Materials & Processes

As readers will be aware, pressure sintering is an alternative to soldering but let's take a detailed look at the materials and how they affect/govern the sintering process.

A sinter paste comprises monometallic particles (typically less than  $1\mu m$  in size), an organic compound (with an evaporation temperature of about  $150^\circ C$ )

and possibly an oxygen reduction agent. Sinter paste OEMs have their own recipes but common to all is that the monometallic particles account for about 90% of the volume.

The material of choice is currently silver. However, all paste OEMs are conducting R&D into copper. The cost of copper is about 5% that of silver, but its use presents many challenges because of how readily the metal oxidises, preventing the formation of good mechanical bonds – unless the entire process is performed in an inert atmosphere.

The most popular method of applying the sinter paste to the substrate (which is typically direct bonded copper, DBC) is using a stencil, where the holes are usually 5 to 10% larger than to die to be placed. The applied paste will typically be between 100 to  $120\mu m$  thick, though some device manufacturers are experimenting with  $80\mu m$ .

The next stage is pre-drying. This tends to be in an oven with a nitrogen atmosphere. The substrate is heated to between  $120$  and  $130^\circ C$  for 30 minutes. This removes any moisture present and results in the thickness of the paste reducing by about 20% while still remaining tacky, as the organic compound is still present.

After drying, the substrate is moved to a pick and place machine. Here, many OEMs are using hot-head tools (at about  $100^\circ C$ ) as it improves the bond quality. Note: the underside of the SiC die is already metalized with silver.

Next, it's to the sinter press. If the substrate is large, it is advisable for the press to have a pre-heating stage. This reduces the risk of thermal stress (warping). Also, if the substrate is a large

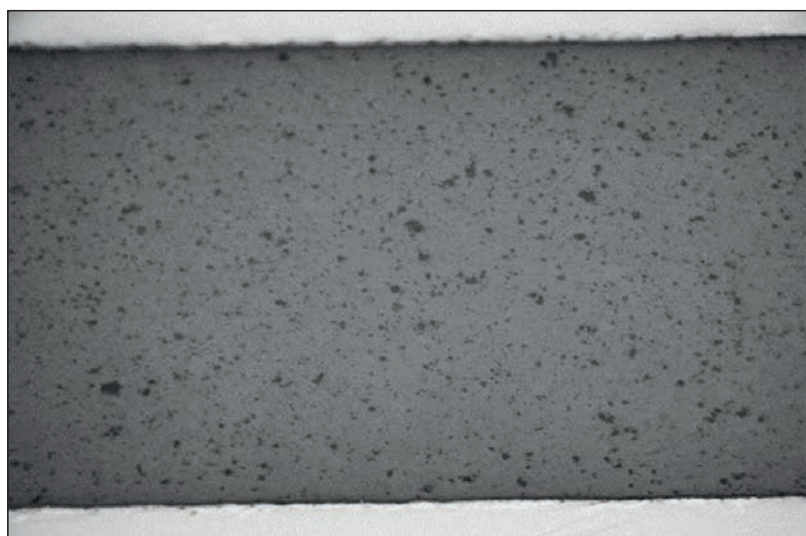


Figure 1 – Above, a cross-section of a BLT.



Figure 2 – Equipment used in the fabrication of a power electronics component/module requiring die to be sintered to the substrate. Not shown, but a recent industry development is the use of a foil with a similar composition to a paste. Printing and pre-drying can be skipped, but the foil is expensive and requires special handling. The technique is more for R&D work than volume production.

thermal mass, it will take longer to reach the sintering temperature, which is about 250°C.

The sintering process is relatively quick, at about 3 minutes. The top of the die is protected using a thin film of Teflon and the sinter tool head presses down, applying a pressure of between 15 and 30MPa. The thickness of the paste reduces by a further 50% as the silver particles bond to produce a bond line thickness (BLT) of between 30 and 40µm – see figure 1.

It is advisable to allow the substrate and die to cool while still in the sinter press to avoid oxidation, before going into test; followed by wire bonding (which might also include tests) and moulding (chip encapsulation). Figure 2 illustrates some of the equipment used in the packaging of sintered die.

### Results

The main method of determining how well the die has attached to the substrate is to perform a mechanical shear test. A shear strength of more than 30MPa should be achievable at room temperature and more than 20MPa during a hot test (typically 100 to 120°C).

One way of increasing shear strength is to silver plate the DBC substrate in the areas where the sinter paste will be applied. This means the interface will be between the silver on the underside of the die, the silver sinter paste, and the silver plate on the substrate. In destructive tests performed by AMX Automatrix, shear strengths of up to 70MPa have been recorded. Without silver plating, dies were shearing at about 55MPa.

Shear strength is also a measure of the presence of voids beneath the die, noting here that to see voids requires a scanning acoustic microscope (SAM). Voids can lead to delamination as a result of thermal



Above pressure sintering using an AMX Automatrix X-Sinter P54.

cycling. Figure 3 shows a SAM image of voids and delamination.

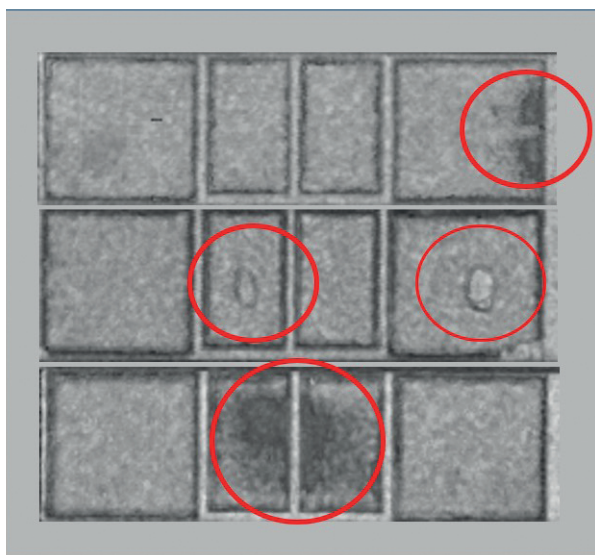
Voids are expressed as a percentage of die area. However, the figures regarding what are acceptable percentages have been inherited from industry standards for attaching die (usually Si) using solder. For SiC, far more power is being handled (to the extent there's likely to be a bang in the event of delamination) and there's a far greater need for efficient heat dissipation. Many believe there should be much tighter

requirements where acceptable void percentages are concerned, and although sinter processes (for electronic component die attach) have not been around long enough for standards to be set, early results are looking good.

Thermal cycling is an essential test, and AMX is aware of some OEMs subjecting sintered components to extremely aggressive tests. For example, some cycle between -55 and 250°C, noting that -40°C is the automotive industry's current low temperature limit. And the jury is out on what should be an upper temperature test limit for SiC, though AMX is aware of one company that is testing to 300°C and its power modules are performing well, i.e., no reduction in shear strength and therefore no indication of delaminating. Also, although 1,000 cycles are standard, many are subjecting their designs to 10,000 cycles.

### Summary

Sintering technology has come a long way in a relatively short period of time, and the use of silver sinter paste has produced some great results and continues to do so. Copper sintering is on the horizon though, driven by the far lower cost of the metal.



**Figure 3 – Left a SAM image of a number of sintered dies. The voids look like bubbles and the dark patches are a sign of delamination.**



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# A high efficiency, 3 kW capable, 2-phase, 3-level Converter using paralleled eGaN<sup>®</sup> FETs

Jianglin Zhu, Michael de Rooij, Efficient Power Conversion

As the revolution of renewable energy as well as transportation electrification progresses, the need for residential energy storage systems is increasing. A high efficiency DC-to-DC converter is usually required to exchange energy generated from renewable sources, such as solar panels, with a battery. The fast-switching speed and low  $R_{DS(on)}$  of gallium nitride (GaN) FETs can help save energy by reducing power consumption inside the DC-to-DC converter[1]. This article shows how to design a high efficiency 100 – 250 V to 40 – 60 V DC-to-DC converter taking advantage of the low  $R_{DS(on)}$  of the EPC2215. A 3-level flying capacitor topology offering a 2x reduction of voltage and current stresses, which improves

overall efficiency, is employed.

Advantages of a 3-level Buck or Boost Converter

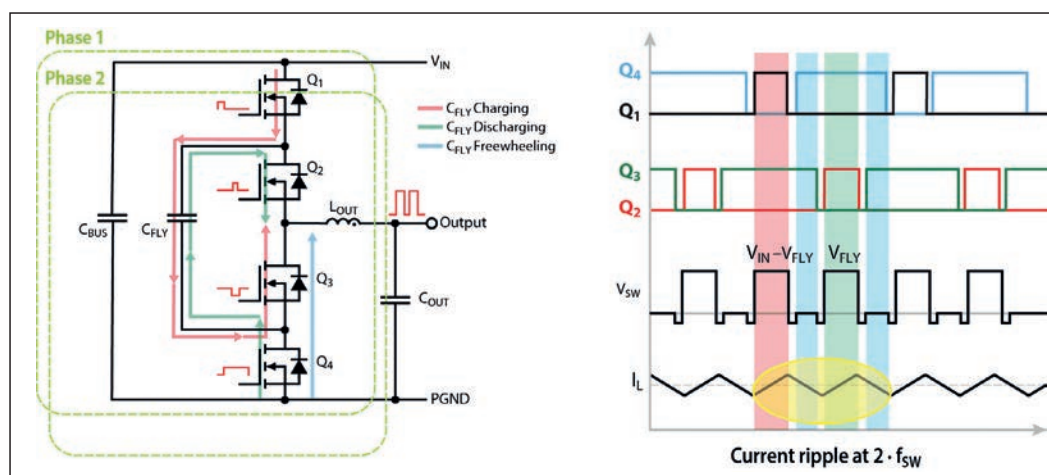
The 3-level flying capacitor buck or boost converter is an attractive topology as it allows for a 2x reduction in FET voltage stress and volt-seconds stress on the inductor, as well as 4x inductance reduction compared to a conventional two-level converter with the same current ripple [2]. Figure 1 shows the operation of the 3-level converter operating in buck mode. One top switch and one bottom switch forms two complementary switch pairs  $Q_1/Q_4$  and  $Q_2/Q_3$ . Top switch  $Q_1$  and  $Q_2$  operate at the same duty cycle but have a 180° phase shift between them, while the bottom switch  $Q_3$  and  $Q_4$  operate

at a complementary duty cycle.

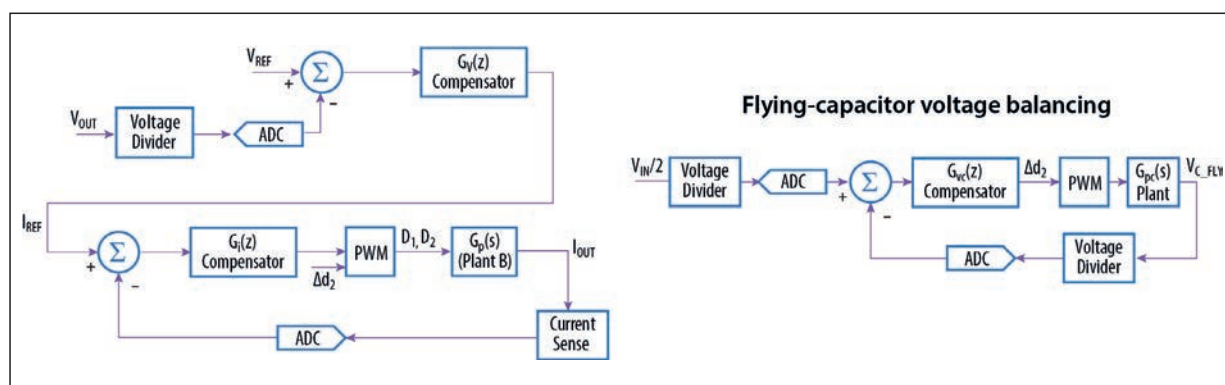
The conventional current mode control can still be applied for this converter, as shown in figure 2. In such configuration, the output voltage loop generates the reference for the inner current loop. To ensure the switches have even voltage stress ( $0.5 \cdot V_{in}$ ) when the switch is off, an additional flying capacitor voltage loop is added to actively regulate the flying capacitor voltage, this can be achieved by adjusting the charging and discharging period of the flying capacitor [3].

## Design Validation

A 3 kW capable experimental 2-phase (1.5 kW per phase) 100 V – 250 V input and 40 V – 60 V output 3-level DC-to-DC



**Figure 1:**  
Operation principle of the three-level converter when  $V_{out}/V_{in} < 0.5$ .



**Figure 2:** Block diagram of output voltage and flying capacitor voltage balancing control loop.



converter, ideal for battery charger applications in energy storage systems, was built and tested as shown in figure 3. It can supply up to 60 A into a 48 V load. The experimental unit comprises two interleaved phases and each phase

employs a 3-level flying capacitor converter topology designed using two EPC2215 FETs [4] connected in parallel for each switch position and operated at 150 kHz switching frequency.

Each phase employs three half-bridge

gate drivers using NCP51820 [5]. The lower FET are driven by a single gate driver for  $Q_3$  and  $Q_4$ . To drive the upper series of  $Q_2$  and  $Q_1$ , two additional high-side gate driver outputs are used. The gate drivers are powered by a cascaded bootstrap circuit. A zoomed-in layout of the switch and capacitor placement is shown in figure 4, where the FETs are located on the bottom side of the board. Low ESL ceramic capacitors are placed between switch pair  $Q_1/Q_4$  and  $Q_2/Q_3$  which act as high frequency decoupling paths to reduce the parasitic inductances associated with the switch positions.

The experimental unit is digitally controlled using a dSPIC33CK controller on EPC9528. The experimental unit is tested with the input on the high voltage port and output voltage regulated down to 40 V. In this mode, the controller is comprised of one single output voltage loop, two current loops and two flying capacitor balancing loops as shown in figure 2. The two current loops share the same current reference generated by the output voltage side to ensure active current balancing. The two phases are interleaved ( $180^\circ$  phase shift) to achieve ripple cancellation on the capacitors.

A measured waveform is shown in figure 5 which shows the switch node of one phase at 24 A output with  $V_{OUT} = 40$  V and  $V_{IN} = 200$  V. Measured, efficiency and power loss at  $V_{OUT} = 40$  V and  $V_{IN} = 200$  V are given in figure 6. In single phase configuration, the converter achieves 97.8% peak efficiency around 14 A output.

The experimental board is equipped with an aluminum heat-spreader and heatsink which can be attached to the back side of the PCB where the FETs are located. The heat-spreader is mounted to the PCB using SMD threaded spacers which are 1 mm tall and use 6 mm long M2 countersunk screws for a flat mounting surface and follow best practice [6]. High performance thermal interface material (TIM) from T-Global (part TG-A1780) is used between the FETs and heat spreader for improved heat conductance. A heatsink

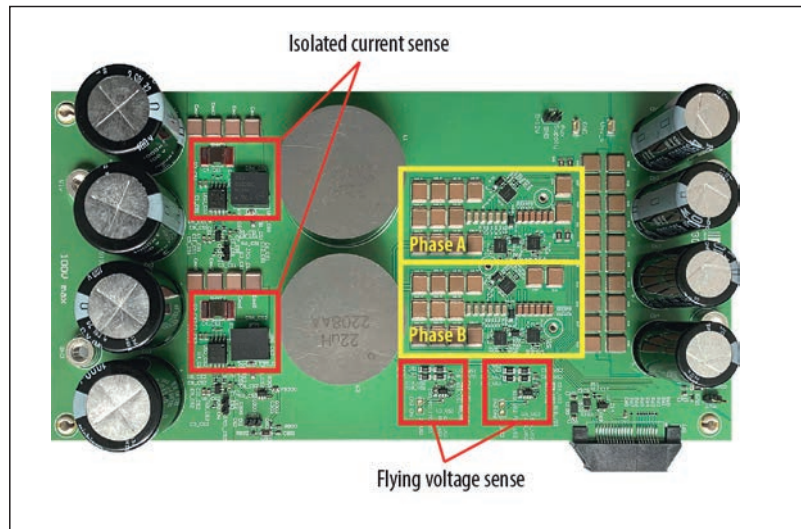


Figure 3: The experimental unit image with identification of that various function circuits.

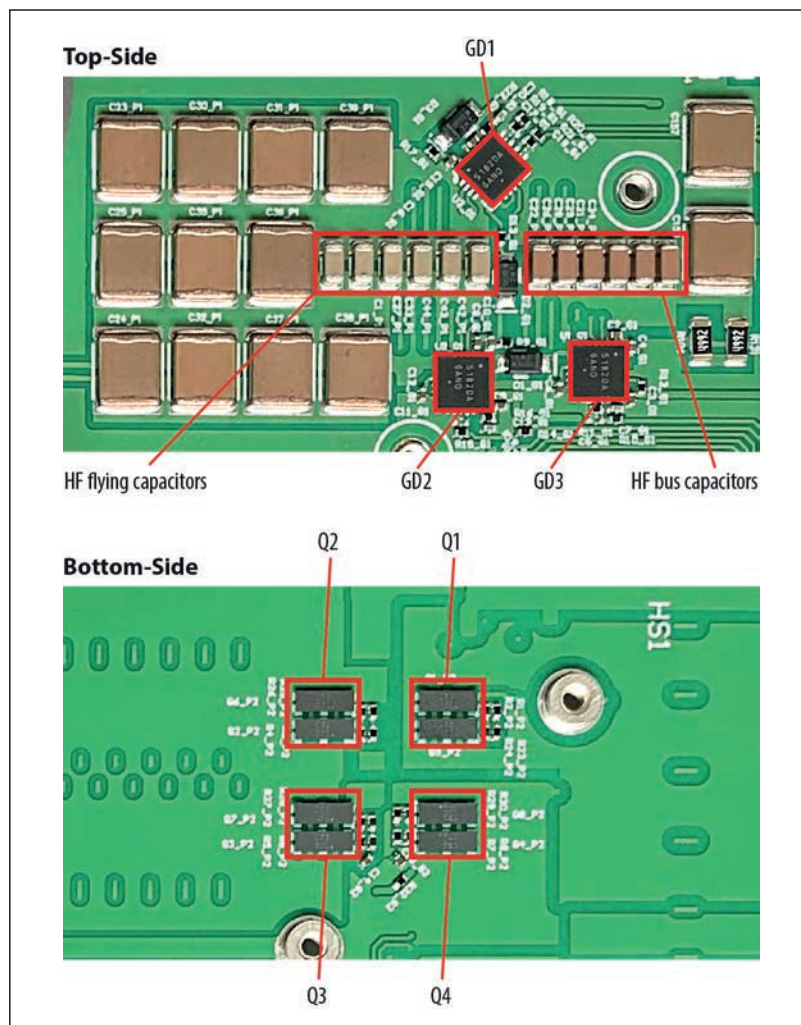


Figure 4: A zoomed in layout of the power stage area showing switches (Q1-Q4) located on the bottom side of the PCB, gate drivers (GD1-3) and capacitor placement.

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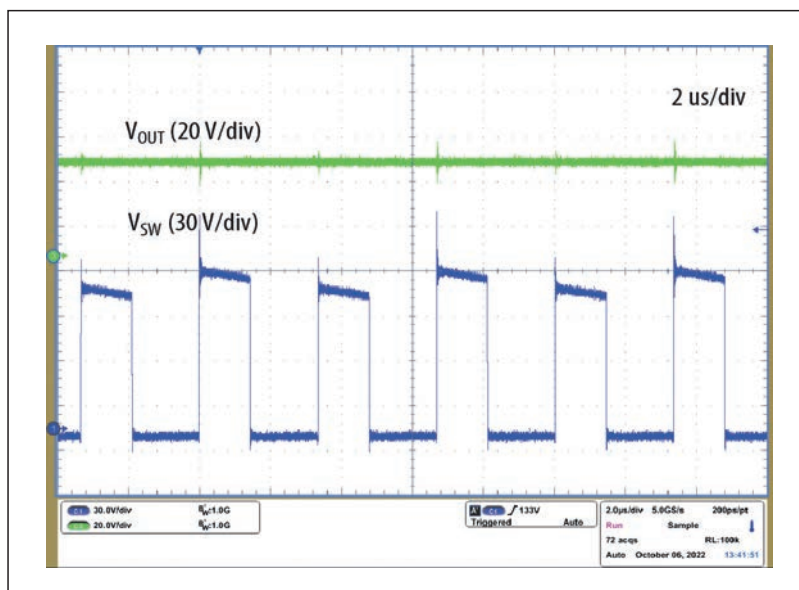


Figure 5: Typical switch node waveforms showing several switching cycles when the board is operating from 200 V input and delivering 24 A into a 40 V load.

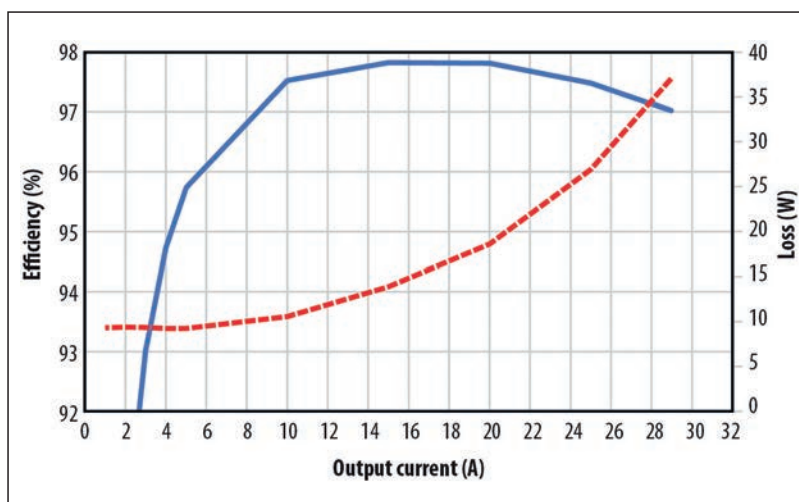


Figure 6: Measured efficiency (left axis) and power losses (right axis) with  $V_{OUT} = 40$  V and  $V_{IN} = 200$  V

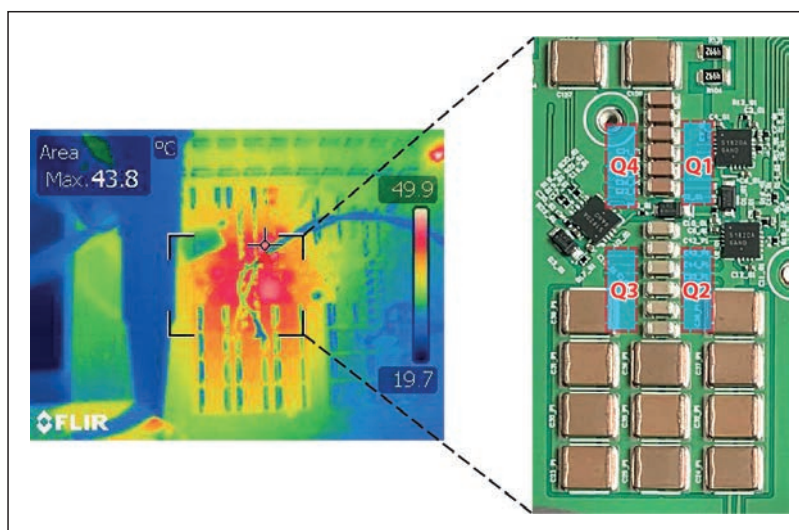


Figure 7: Thermal image taken from the top side of the PCB when operating from 200V input and delivering 24 A into 40 V load in an ambient of 20°C

is attached to the flat mounting face of the heat-spreader. A two-part gap filler TIM (Bergquist GF4000) is used for the thinnest bond line thickness, and to provide some adhesion between the heatsink and heat-spreader. With this cooling method, figure 7 shows temperature measurements taken from the top side of the PCB with IR camera and only a 30°C temperature rise is recorded. The air flow used is around 1500 - 2000 LFM.

### Conclusion

This article presented the design of a 3 kW capable 2-phase (1.5 kW single phase) DC-to-DC converter reference design using eGaN FETs, EPC2215. A 3-level topology is used which allows for 2x reduction in voltage stresses in the switches. In the experiment, 97.8% peak efficiency is achieved at 200 V input and 40 V output. The temperature rise of the FET is around 30°C with top side cooling using a heat-spreader and heatsink.

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## AC/DC active bridge rectifier reduces standby power in adapters

Available in an SOP-8L package, the AOZ7203AV is a self-powered dual driver IC for driving external high-voltage MOSFETs and can replace two low-side diodes of bridge rectifier. It is suitable for use in adapters for high-end laptops and televisions, as well as power supplies for desktops, game consoles and servers, advises the company.

The rectifier features a high withstand voltage, a self-powered Vcc supply from the AC line, low operation current and X-capacitor discharge (CB safety certified).

A break-before-make circuit avoids the overlap of two gate driving and an active bridge rectifier circuit drives the low-side, high voltage MOSFETs. Input voltage is up to 600V which ensures a wide operating ambient temperature range of -40 to 125°C, driving low RDSon HV MOSFETs to gain more efficiency improvement of AC power supply. The AOZ7203AV can replace lossy diodes in the bridge rectifier circuit of an AC/DC power supply.

"Using the low-Ohmic high voltage external MOSFETs significantly improves the efficiency of the power converter as the typical rectifier-diode forward-conduction losses are reduced by 50%" explains Armin Hsu, power IC senior marketing manager at AOS. "Efficiency can improve up to about 0.7% at 90V mains voltage," he added.

Benefits include drain source over-voltage protection for all external power MOSFETs. There are also space savings, as two drivers in one package enable a more compact design, says the company.

The AOZ7203AV is immediately available in production quantities with a lead time of 14 weeks. All products from the company are offered in packages with Pb-free plating and are RoHS-compliant.

## BD7xxL05G-C series of primary LDOs maintain power for core vehicle functions

The BD7xxL05G-C series comprises the BD725L05G-C, BD730L05G-C, BD733L05G-C and BD750L05G-C compact LDO regulators. They are optimised for automotive's redundant power supplies in systems such as ADAS and a vehicle's safety systems which rely on redundant power supplies to continue the operation of core functions in the event of a main system malfunction.

The regulators are designed for the limited space in a vehicle and feature a rated input voltage of 45V and 50mA output current. The BD7xxL05G-C series LDO regulators measure 2.9 x 2.8mm and provide high withstand voltage up to 45V with low current consumption of 6µA (typical) to meet key

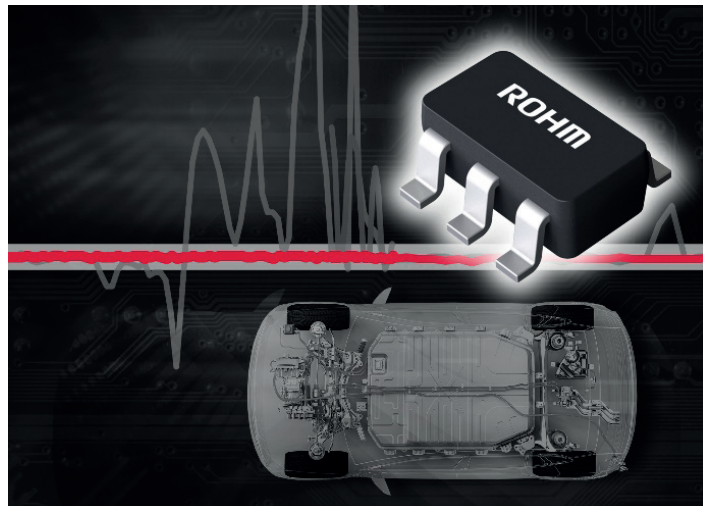
requirements for building redundant power supplies. They also have stable output voltage even during steep battery voltage fluctuations, with less than 50mV ( $\pm 1\%$ ) over the entire frequency band under ISO 11452-2 antenna irradiation testing, reducing the design load for noise counter-measures, says the company.

Unlike standard products with an overshoot of almost 1.3V that require a large output capacitor to prevent the rated voltage of downstream devices being exceeded, these LDOs limit voltage overshoot to just 0.1V. As a result, says Rohm, they can support much smaller output capacitors. There is no need for a voltage clamping diode which further contributes to reducing the required board area. It is estimated to be approximately 29% less compared with general solutions and also minimises the number of additional circuits needed to configure redundant power supplies.

The BD7xxL05G-C series meets requirements such as support for 125°C (ambient temperature) operation and the regulators are qualified to AEC-Q100.

The LDOs are designed for applications that operate when the engine is stopped, for example, brake systems, body control modules, electric power steering, battery control units, ADAS engine control units (ECUs), real time clocks, drive recorders and door handle modules.

The LDOs are in mass production now and available from online distributors, Digi-Key, Mouser and Farnell with other distributors scheduled for later release.



## Cosel adds 700W model to medical and industrial supply

For efficient cooling in demanding medical and industrial applications, the power supply uses thermal conduction and has a power density of 31.1W per cubic inch. According to the company, this makes it one of the highest power density power supplies in its category for powering medical and industrial applications.

It is designed in accordance with safety standard IEC 60601-1, for BF (body floating) medical applications. Its high isolation and creepage distance also make it suitable for industrial applications. It complies with EN61558-2-16 (OVC III) and simplifies design to conform to EN60335.

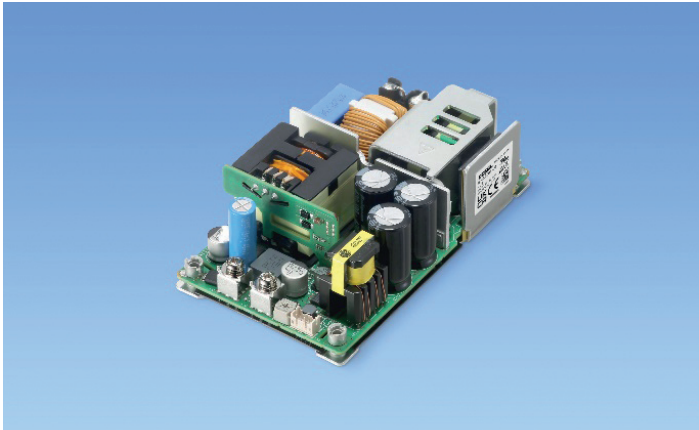
The GHA700F is available in four output voltages: 24V DC / 29.2A, 30 V DC / 23.3A, 48V DC / 14.6A, 56V DC / 12.5A. Universal input voltage is 85 to 264V AC. Output voltage can be adjusted using the built-in potentiometer.

The GHA700F is up to 96% efficient. It includes inrush current limitation, over-current protection with automatic recovery when the fault condition is removed, and over-voltage protection. Operating temperature range is -20 to 70°C or up to 80°C chassis. Depending on the final equipment assembly and cooling conditions, a derating may apply, adds the company.

The power supply includes an active power factor corrector with a co-efficient of up to 0.95.

The GHA700F has a 4,000V AC (2MOPP) input to output isolation voltage,





2,000V AC (1MOPP) input to frame ground (FG) and 1,500V AC (1MOPP) output to FG. In the case of the BF application, the GHA700F complies with the patient leakage current level of less than 100 $\mu$ A.

The GHA700F has received UL62368-1, EN62368-1, c-UL (equivalent to CAN/CSA-C22.2 No.62368-1), ANSI/AAMI ES60601-1, EN60601-1 3rd, c-UL (equivalent to CAN/CSA-C22.2 No.60601-1) approvals and complies with IEC60601-1-2 4th Edition and EN61558-2-16 (OVC III).

In conducted emission tests, the GHA700F complies with the FCC-B, VCCI-B, CISPR32-B, EN55011-B and EN55032-B. For further improved noise performance COSEL offers EMI / EMC filters type EAC-16-472.

The power supply is available with options including conformal coating, isolated 5V and 12V auxiliary output, remote control - power good, M3 threaded mounting hole, with an external hold-up time extension unit and models with a reinforced isolation in compliance with the IEC class II.

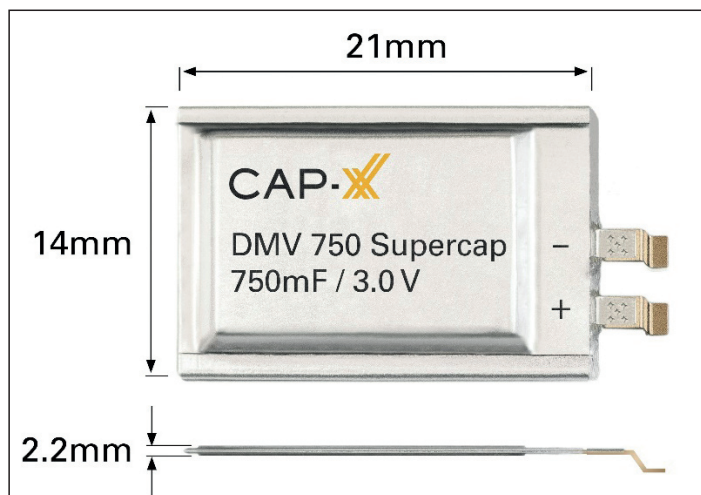
The GHA700F has a five-year warranty and conforms to the European RoHS and Low Voltage Directives.

## Cap-xx has developed supercapacitor for IoT and batteryless devices

The DMV750 thin 2.2mm prismatic 3V supercapacitor is suitable for IoT, medical and other space-constrained and mission-critical electronic devices.

It can efficiently store and release the energy needed to drive peak-power functions in IoT, medical and other space-constrained and mission-critical electronic devices. The 750mF supercapacitor can complement 3V coin cell batteries, replace bulky 3V cylindrical supercaps to save design space, or replace batteries altogether when energy harvesters can extract enough solar, vibration, RF or other environmental energy to charge the ultra-efficient supercapacitor in sustainable batteryless devices.

The DMV750 provides high peak pulse power to enable either batteryless



or more battery-efficient applications. It measures 21 x 14 x 2.2mm and has an operating temperature range of -20 to 85 degrees C.

Target applications include energy harvesting for remote wireless sensors, wireless HVAC sensors and actuators, asset tracking, real time clock and memory back up power and peak load shaving when configured in parallel with a 3V coin cell battery, like the CR2032.

Samples are available now.

## DC-DC converter series expanded with 6W and 10W surface mount and through-hole models

TDK Corporation (TSE 6762) announces the introduction of 6W and 10W models to the TDK-Lambda CCG series of DC-DC converters, suitable for either through hole or surface mount placement. This expands the CCG series to cover 1.5W to 30W. In addition to battery powered equipment, applications include process control, data communications, telecommunications and test and measurement related products.

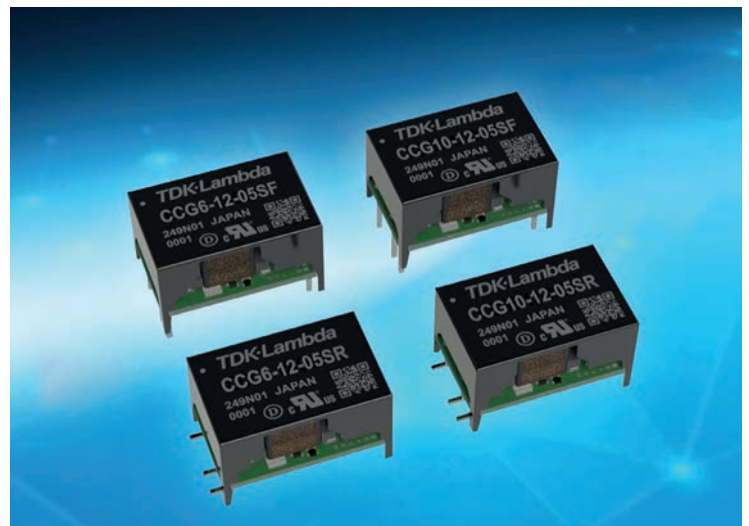
The CCG6 (6W) and CCG10 (10W) series are available with output voltages of 3.3, 5, 12, 15,  $\pm 12$  or  $\pm 15$ V with the capability of operating the dual models to provide a single 24 or 30V output. All voltages and output power combinations can operate from either a 4.5 to 18V, 9 to 36V or 18 to 76Vdc input, providing an additional 36 output voltage and current models to the CCG product family.

Using the trim terminal, the single output models can be adjusted by -5% to +10% of the nominal output voltage for non-standard settings or to compensate for voltage drops. All models are protected against an over-current condition and have an input to output isolation voltage of 1,500Vdc. The remote on/off function can be used to turn the output off, or alternatively place the DC-DC converters in standby mode, reducing the input power consumption to typically <0.1W, to extend the battery life when used in portable equipment.

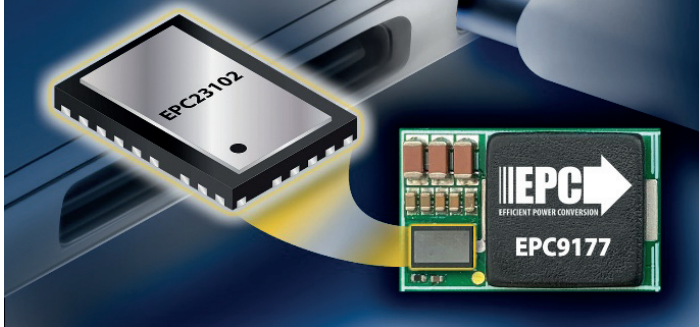
The CCG6 and CCG10 share a common footprint of 19mm x 12.4mm (length x width) with a height of 11.5mm for the through-hole and 11.8mm for the surface mount models. The plastic case contains no encapsulant, avoiding quality risks associated with silicone potting compounds during reflow-soldering. The highly automated production line utilises X-ray inspection to inspect solder joints for higher reliability.

The operating temperature range for the CCG6 is from -40 up to +95°C and -40 up to +90°C for the CCG10 using convection or forced air cooling. Safety certification includes IEC/UL/CSA/EN 62368-1 with CE and UKCA marks to the Low Voltage and RoHS Directives.

For more information about the TDK-Lambda CCG series, please call TDK-Lambda directly on +44 (0)1271 856600 or follow this link.



## EGaN IC reference design addresses USB PD 3.1



The eGaN IC-based reference design addresses new USB PD 3.1 stringent demands for multi-port chargers and on-motherboard DC/DC converting a 28 to 48V input to 12 or 20V output.

The EPC9177 digitally-controlled, single output synchronous buck converter reference design board operates at 720kHz switching frequency, converting an input voltage of 48, 36 or 28V to a regulated 12V output voltage and delivering up to 20A continuous output current.

The compact synchronous buck converter measures 21 x 13mm and a low profile of 3.0mm. It features the EPC23102 integrated half-bridge ePower stage and is optimised for computing power supplies and USB PD 3.1 multi-port chargers and on-board DC/DC.

In USB PD 3.1 applications, the output voltage for USB charging increases from 20 to 48V and power increases from 100 to 240W. This higher power enables USB charging beyond laptop and cell phone fast charging to higher power applications including gaming PCs, power tools and e-bikes. The main output of chargers is 48V to allow the higher output power with 5.0A rated cables, but multi-port chargers can also support lower output voltages (e.g. 5.0, 12 and 20V) to be compatible with a wider range of devices. A smart DC/DC regulator is required to generate these lower voltages and a DC/DC regulator is required on the end product's motherboard to convert the input voltage.

The EPC23102 GaN power stage integrates the half bridge driver and FETs (100V, 6.6 mΩ RDSon, the level shifter and the bootstrap charging and can switch with very high efficiency up to 3MHz. It enables the EPC9177 reference board to deliver up to 20A continuous current using a heatsink and 15A continuous current without a heatsink to 12V output voltage, with greater than 97.3% efficiency with a 48 V input.

The reference design is suitable for high power applications including computing, industrial, consumer and telecoms power systems which require high efficiency but a small size. eGaN FETs and ICs provide the fast switching, high efficiency and small size that can meet the stringent power density requirements of these leading-edge applications, says EPC.

The EPC9177 reference design board is available from EPC and available for immediate delivery from Digi-Key.

## ESD protection for in-vehicle bus lines are qualified to AEC-Q101

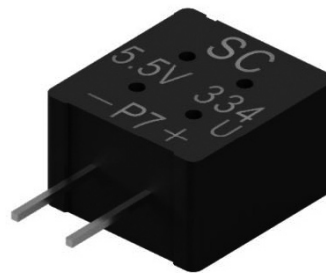
The PESD2CANFD36XX-QA devices are offered in a variety of packages and capacitance classes for commercial vehicle applications. The six AEC-Q101-qualified ESD protection devices protect bus lines in automotive in-vehicle networks, for example LIN, CAN, CAN-FD, FlexRay and SENT, from damage caused by ESD and other transients. The increase in data rates and electrification within vehicles means that the need for ESD protection is becoming ever more critical, says the company.

Lorries, trucks and commercial vehicles typically use 24V board nets, larger than the battery voltage found in cars and smaller vehicles. ESD protection



devices with operating voltages typically above 32V are required to safeguard sensitive signal lines in 24V board nets. The ESD devices have been designed to have a maximum reverse standoff voltage of 36V and up to 22kV ESD protection. They also have a low clamping voltage of 48V VCL at IPP of 1.0A for robust in-vehicle networks.

The devices are available in SOT23 and SOT323 packages and three low capacitance classes (4.3, 6.0 and 10pF) for smooth communication between interfaces without impacting signal integrity.



## Miniature automotive supercapacitor delivers fast charging

The miniature supercapacitor delivers power density and fast charging in automotive electronic applications, says the company.

The FMU supercapacitor series delivers 1,000 hours at 85°C/85% RH-rated voltage and, claims Kemet, has an industry leading operational temperature range from -40°C to 105°C. The supercapacitors are qualified to an automotive testing protocol and manufactured in an ISO TS 16949-certified plant and subjected to PPAP/PSW and change control.

Suitable automotive applications are those which require a main power system back-up during a power loss, such as ADAS (advanced driving assistance system), autonomous vehicles and central gateway ECUs (engine control units).

Supercapacitors maintain the main power system's real-time clock or volatile memory when it is removed, such as during a power failure or when the main power system's battery has been removed for replacement. They also offer power back-up in equipment ranging from IoT devices, smart meters, medical devices and industrial computing.

The FMU miniature supercapacitors use a proprietary aqueous electrolyte that provides high durability against liquid leakage, vibrations and thermal shock for reliability in harsh environments. Aqueous electrolytes are highly conductive, have a low environmental impact and are non-toxic and non-flammable. Unlike a battery, supercapacitors store and release energy quickly through physical adsorption and the ions desorption in the electrolyte between its electrodes. The supercapacitor's low internal resistance means they can fully charge within a few seconds, compared to a secondary battery cell which can take from 10 minutes to several hours to fully charge. Moreover, there is no theoretical limit to the life cycle, whereas a lithium-ion secondary cell has a finite lifetime of about 500 cycles. They also typically have a greater resistance to moisture absorption than organic compounds, for a longer life with better stability, says the company.

Kemet is a Yageo Group company. The FMU supercapacitors are available immediately via distributors.



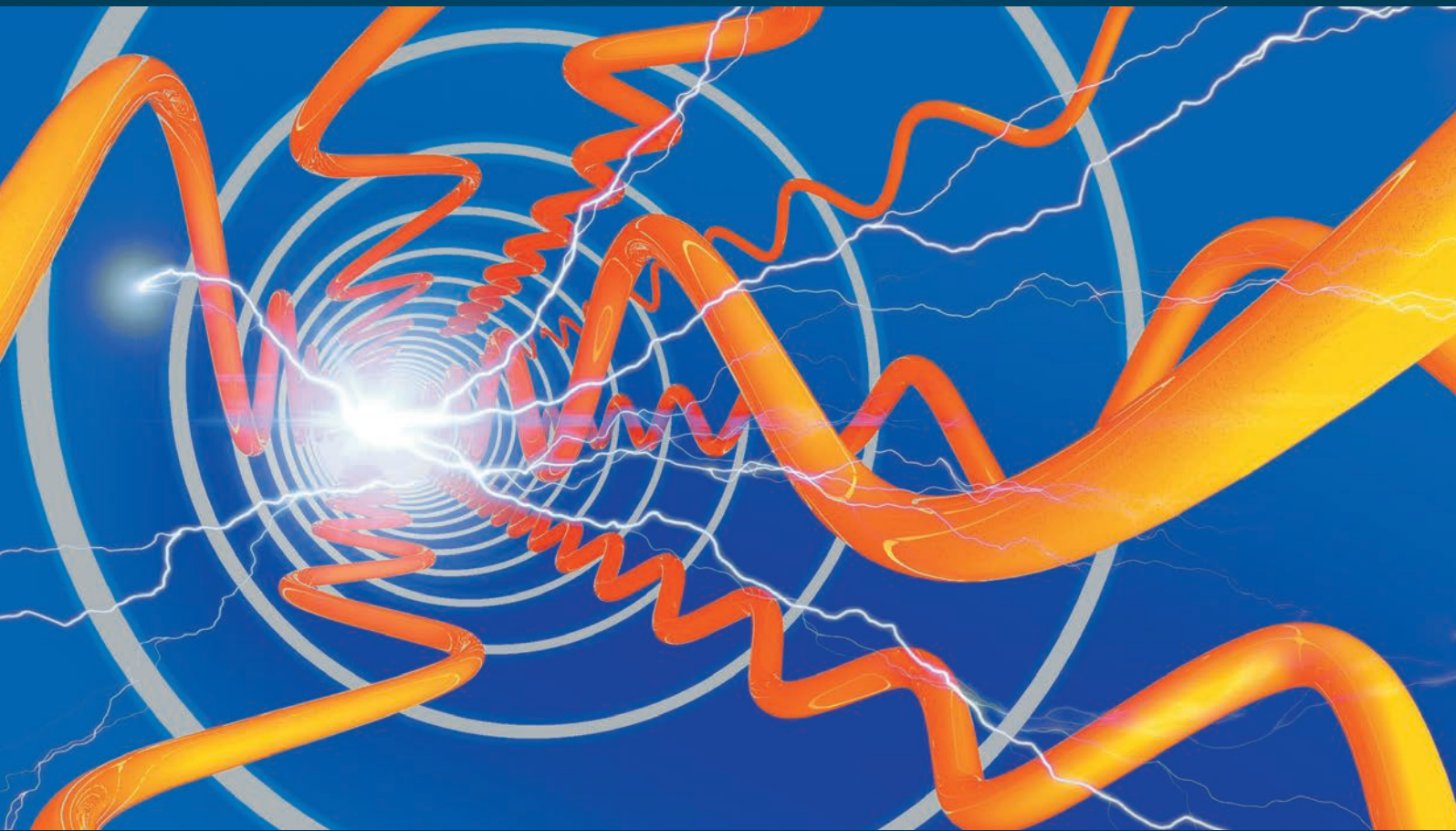
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## Planar transformer series is engineered for high frequency, smaller spaces

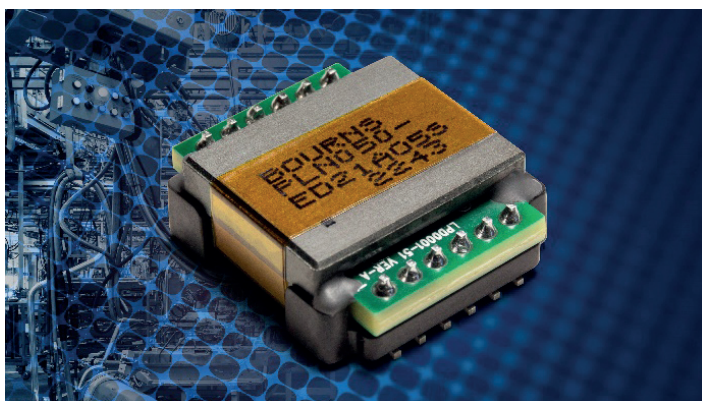
The planar transformers have features required to meet today's high frequency, smaller space power conversion application requirements, said the company. These forward converter transformers have high volumetric power density and low loss in a compact, low height package.

They also have enhanced thermal conduction and heat dissipation for greater reliability. Planar-style transformer components increase design flexibility and offer efficiency advantages over conventional wirewound transformer designs due to significantly reduced AC resistance losses, explains Bourns. The PLN0xx-ED21 transformers have leakage inductance from 0.297H to 0.607H and a volt-second time of 81.6V-µsec.

The series offers 33 to 57V input voltage, 5.0 to 12V output voltage at 4.0 to 14A output with various turns ratios. As a result, the planar transformers are suitable for power conversion in high density industrial power systems, low profile switched mode power supplies (SMPS), LED lighting applications, battery management systems and PoE applications.

Standard PWB material is used for the transformer windings, which are soldered to an SMT header to create a surface mount component designed for ease of assembly. The company's custom magnetics product engineers are able to support many modification and customisation requests.

The PLN0xx-ED21 series planar transformers are available now and are RoHS-compliant.



## Power AC/DC converters from Recom extend board mount range

The AC/DC power supply has a package size of 1.6 x 2.0 x 1.0 inch or 40 x 52.5 x 25.5mm. The RACM30-K/277 series provides 30W continuous power (36W peak) across an ambient range of -40°C to 60°C in free air and up to 90°C with derating.

The wide input range is 85 to 305V AC (120 to 430V DC) and regulated and fully protected outputs available are 5.0, 12, 15, 24,  $\pm 12$  and  $\pm 15$ V, rated as 'limited power source'. The class II insulation parts are rated for harsh over-voltage category III (OVC III) and pollution degree 3 (PD3) environments up to 5000m altitude. Safety certifications include audio/video, IT, test equipment, industrial, household, and MOPP medical, with 4kVAC/1 min, rated isolation.

No-load/standby dissipation meets eco-design requirements with near-flat efficiency curves down to light loads and all parts meet 'class B' EMC standards with a wide margin without external components, even with grounded outputs.

The RACM30-K/277 series uses silicon-free encapsulation and the board-mount module has an industry-standard pinout. The parts are optionally



available with flying leads or as panel-mounted with clip accessories to enable DIN-rail mounting.

Typical applications for the series include house-keeping power in EV chargers, industrial automation, lighting, IoT, medical, and smart energy systems.

The AC/DC power supplies are covered by a three-year warranty. Samples and OEM pricing are available from all authorised distributors or directly from the manufacturer.

## Vishay offers high current rectifiers in DFN package

Three automotive-grade, surface-mount standard rectifiers are the industry's first devices in the low profile DFN3820A package with wettable flanks, says Vishay Intertechnology. The 2A SE20Nx, 3A SE30Nx and 4A SE40Nx space-saving, high efficiency rectifiers are for power line polarity protection and rail to rail protection in commercial, industrial, and automotive applications. They are available with reverse voltages of 200V, 400V and 600V.

The first package in Vishay's Power DFN family, the DFN3820A, has a 3.8 x 2.0mm footprint and a low typical height of 0.88mm. According to Vishay General Semiconductor, the rectifiers make more efficient use of PCB space and have optimised copper mass design and advanced die placement technology for thermal performance that enables operation at higher current ratings.

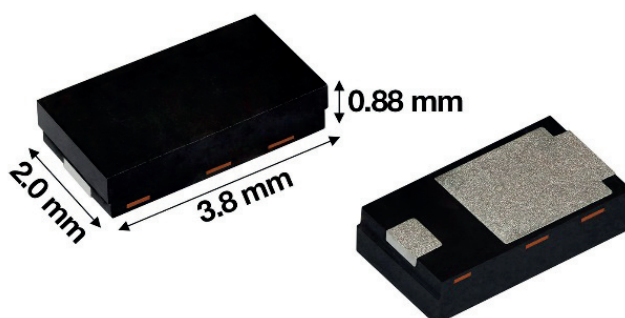
Compared to devices in the SMP (DO-220AA) package with the same footprint, the AEC-Q101-qualified SE20Nx, SE30Nx, and SE40Nx offer a 12% lower profile and double the current rating. They also offer equivalent or higher current ratings to larger devices in the conventional SMB (DO-214AA) and SMC (DO-214AB) packages, as well as the eSMP series SlimSMA (DO-221AC), SlimSMAW (DO-221AD), SMPA (DO-2212BC), and SMPC (TO-2778A).

They have an oxide planar chip junction design, allowing the rectifiers to offer typical reverse leakage current of less than 0.1µA. The low forward voltage drop down to 0.86V to reduce power losses to improve efficiency.

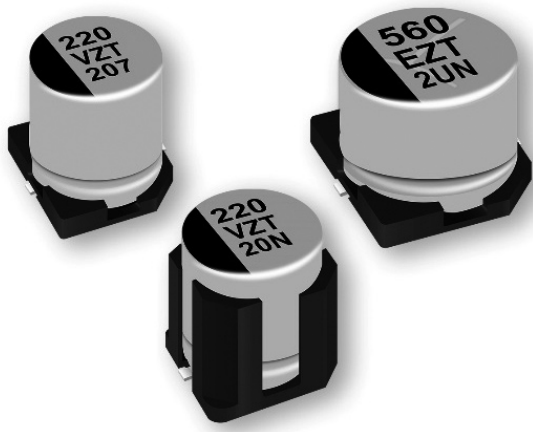
The devices operate over a wide temperature range from -55°C to 175°C and provide ESD capability in compliance with IEC 61000-4-2, air discharge mode.

The rectifiers are suitable for automated placement, the rectifiers offer a MSL moisture sensitivity level of 1, per J-STD-020, LF maximum peak of 260°C. The devices are RoHS-compliant and halogen-free.

Samples and production quantities of the surface-mount standard rectifiers in a DFN3820A package are available now, with lead times of 12 weeks.







## Hybrid capacitor series sets new standards, says Panasonic Industry

Extending the portfolio of electrolytic polymer hybrid capacitors available from Panasonic Industry, the ZTU series is an AEC-Q200-qualified series, designed for reliability and rugged operation. It joins the existing ZT and ZC capacitor series.

It is available with a rated voltage 25 to 35V DC / 220 560 $\mu$ F and an 80% increase in ripple current capability compared to the ZC series, says the company. The ZTU has been proven for 4000 hours at 125°C and 135°C for applications where high temperature tolerance and high current capability is required.

Suitable applications are in DC/DC or AC/DC inverters, robotics, rectifier circuits as well as automotive applications where conditions are harsh and demanding.

The company also offers a vibration-proof version in both 8.0 and 10mm diameter versions. They are able to handle shocks of up to 30G, while the standard parts have a vibration tolerance of 10G.

According to Panasonic Industry Europe's Hirofumi Maruyama: "The ZTU series is setting new standards with its ripple current and capacitance specs and reliably guarantees circuit safety at one of the highest temperature ranges currently available on the market".

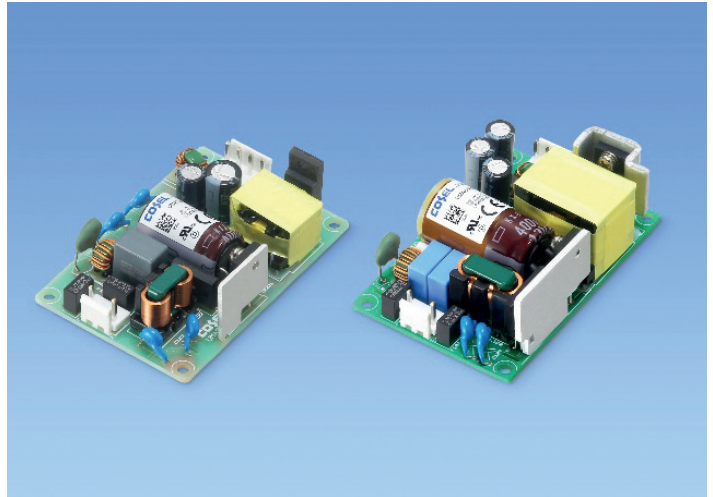
## Compact power supply is suitable for medical applications

The first two models in the UMA series are the 30W UMA30F and the 60W UMA60F. The UMA30F measures 50.8 x 76.2mm and 21.7mm high or 24.2mm for the UMA60F. The power supplies have a universal input range

of 85 to 264V AC. They comply with international safety standards and are designed for demanding body floating (BF) applications. They comply with 2MOPP (in/out) and 1MOPP (out/FG or frame-ground) safety requirement. They are available in up to five output voltages of 5, 12, 15, 24, and 48V DC.

Medical applications require robust and reliable power supplies, says Cosel. The company's flyback topology enables the power supplies to be operated within a universal input range of 85 to 264V AC, and with a typical efficiency up to 91% at high line.

There are four single output voltages available as standard for the UMA30F



model: 5V/3A, 12V/2.5A, 24V/1.3A and 48V/0.65A. There are five options in the UMA60F model: 5V/6A, 12V/4.5A, 15V/3.5A, 24V/2.5A and 48V/1.25A. Output is factory adjusted to a fixed value, but in applications where output voltage adjustment is required an option with potentiometer is available.

Features in the UMA series include inrush current limiting circuitry, over-current, and over-voltage protection. The power supplies can be operated in an environmental temperature range of -20 to 70 degrees C. A derating may apply, depending on the final equipment assembly style and cooling conditions, advises the company.

The UMA series' models are approved in accordance with ANSI/AAMI ES60601-1 and EN60601-1 3rd Edition. In the case of body floating applications where patient leakage current must be less than 100 $\mu$ A, with its 75 $\mu$ A figure, the power supplies are below that limit.

The UMA series meets ANSI/AAMI ES60601-1, EN60601-1 3rd, C-UL (equivalent to CAN/CSA-C22.2 No.60601-1), UL62368-1, EN62368-1, C-UL (equivalent to CAN/CSA-C22.2 No.62368-1) and complies with EN60335-1.

Three options are available including adjustable output voltage (Y), terminal block (T), and for applications requiring additional safety the UMA30F and UMA60F are available with reinforced isolation in conformance with the IEC class II (E).

The UMA30F weighs 80g and the UMA60F weighs 120g maximum.

The UMA series has a five-year warranty and conforms to the European RoHS and Low Voltage Directives.

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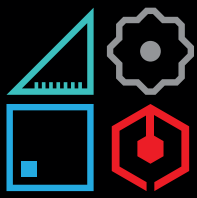
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