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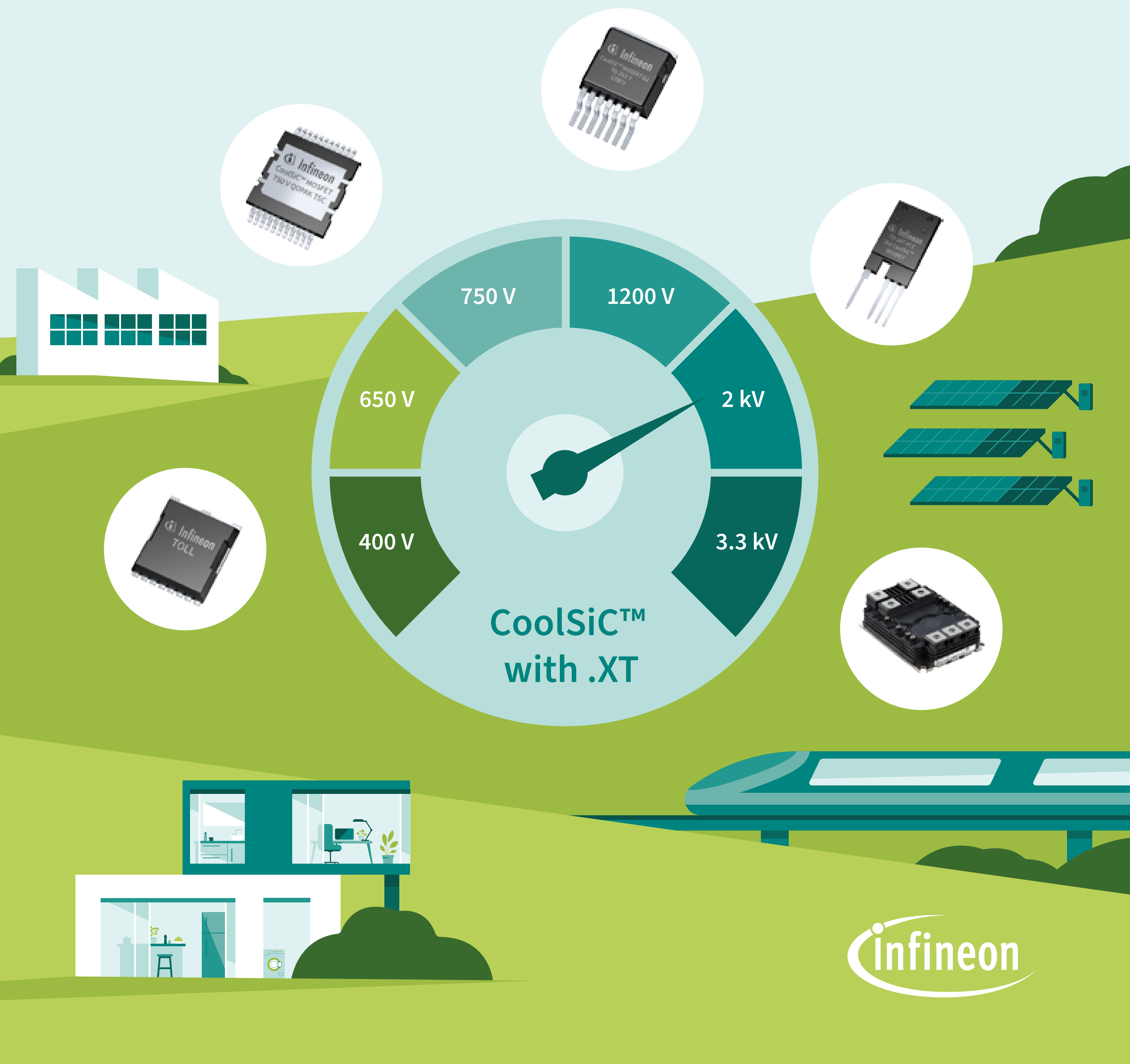
Bodo´s Power Systems®

Electronics in Motion and Conversion

May 2024

CoolSiC™ with .XT technology – Extending your Application Lifetime



PULSED INDUCTANCE MEASUREMENT

POWER CHOKE TESTER DPG10/20 SERIES

Inductance measurement from 0.1 A to 10 kA

KEY FEATURES

Measurement of the
- **Incremental inductance** L_{inc}(i) and L_{inc}(∫Udt)
- **Secant inductance** L_{sec}(i) and L_{sec}(∫Udt)
- **Flux linkage** ψ(i)
- **Magnetic co-energy** W_{co}(i)
- **Flux density** B(i)
- **DC resistance**

Also suitable for 3-phase inductors

APPLICATIONS

Suitable for all inductive components from **small SMD inductors** to **very large power reactors in the MVA range**
- **Development, research** and **quality inspection**
- **Routine tests** of small batch series and mass production

KEY BENEFITS

- Very **easy and fast** measurement
- **Lightweight, small and affordable price-point** despite of the high measuring current up to 10000A
- **High sample rate and very wide pulse width range** => suitable for all core materials

AVAILABLE MODELS

Model	max. test current	max. pulse energy
DPG10-100B	0.1 to 100A	1350J
DPG10-1000B	1 to 1000A	1350J
DPG10-2000B	2 to 2000A	1350J new model
DPG10-2000B/E	2 to 2000A	2750J new model
DPG10-3000B/E	3 to 3000A	2750J
DPG10-4000B/F	4 to 4000A	8000J
DPG20-10000B/G	10 to 10000A	15000J

Technological leader in pulsed inductance measurement for 20 years

www.ed-k.de

Content

MARK YOUR CALENDAR:

Bodo's WBG Event 2024

December 3 - 4

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Between APEC and PCIM

As you know several members of our editorial team recently attended APEC, and in our last issue (April) we featured a highly-compressed report about this important US event. In April I visited the Embedded World show in Nuremberg even though this is an embedded systems show and no power event at all. However, as every embedded system needs power to operate, I decided to attend and met many companies and friends in the power supply business.

Even though I am really fascinated by high-power applications and wide bandgap-enabled power supplies one of the most impressive meetings I had at Embedded World was with a company active in the energy harvesting business. They showed solutions where conventional batteries are replaced with a tiny rechargeable lithium-ion battery, an energy management (power) IC and e.g. a really small photovoltaic cell. In terms of battery exchange logistics and continuous operation/longevity this is an essential step forward, and in terms of environmental protection this is another significant advancement because it means that disposable batteries are no longer used for this application, thereby reducing the amount of waste. But this was just an excursion into the world of ultralow power applications. Our main focus is and will remain on higher power applications.

We are busy preparing for the PCIM show, where our entire editorial team will be present for three days. Following the tradition Bodo has once again invited leading executives of the wide bandgap industry to attend our very special session at the PCIM Technology Stage in Hall 7 on Wednesday.

When I talked to Bodo about this unique information format he called it "like speed dating" because the experts will present the real highlights of the Silicon Carbide and Gallium Nitride industry. Each speaker has a maximum of five minutes to present. Bodo calls this speed dating, I call it a highly compact and extremely efficient industry update. During this "WBG information pressure refueling" Bodo's Power Systems will bring you with the latest technology within an hour. **So please reserve these time slots in your calendar and arrive early to learn about SiC from 11:20 to 12:15 and from 13:15 to 14:15 as well as about GaN from 14:20 to 15:20.**

Bodo's magazine is delivered by postal service to all places in the world. It is the only magazine that spreads technical information on power electronics globally. We have EETech as a partner serving our clients in North America. If you speak the language, or just want to have a look, don't miss our Chinese version at bodospowerchina.com. An archive of the magazine with every single issue is available for free at our website bodospower.com.

My green tip of the month:
Try to avoid disposable batteries in your designs whenever energy harvesting solutions (and a small rechargeable battery) might make sense as well. Discuss with your team the soft benefits of more environmentally friendly solutions because very often green solutions enable a better TCO (total cost of ownership – over the product lifetime). Let your marketing and product definition people know about your design team's green design skills; dare to walk the green power path!

Alfred Vollmer

Events

Fortronic 2024
Bologna, Italy May 7 – 8
www.e-tech.fortronic.it

CWIEME Berlin 2024
Berlin, Germany May 14 – 16
https://berlin.cwiemeevents.com

ECCE Asia 2024
Chengdu, China May 17 – 20
www.ipemc-conf.com

The Magnetics Show 2024
Pasadena, CA, USA May 22 – 23
www.magnetics-show.com

ISPSD 2024
Bremen, Germany June 2 – 6
www.ispsd2024.com

PEMD 2024
Nottingham, UK June 10 – 13
https://pemd.theiet.org

GaN Marathon 2024
Verona, Italy June 10 -12
www.ganmarathon.com

PCIM Europe 2024
Nuremberg, Germany June 11 – 13
www.pcim-exhibition.com

Sensor + Test 2024
Nuremberg, Germany June 11 – 13
www.sensor-test.de

Semiconductor Manufacturer fully merges its Subsidiary

ROHM announces an absorption-type merger of its fully owned subsidiary LAPIS Technology on April 1, 2024. The merger is intended to integrate the technologies of ROHM and LAPIS Technology. The newly-organized company will work as one to develop products that meet the needs of its customers. ROHM explicitly reassured that the business relationship with its customers as well as the existing products of LAPIS Technology will be continued by ROHM.

"Amid dramatic changes in the business environment in the semiconductor industry, it is necessary to build a robust group-wide management structure in order to improve competitiveness", ROHM reports. "LAPIS Technology is a wholly owned subsidiary responsible for the planning and development of IC products. By enhancing the integration density of the technologies that both companies excel in, we will not only cultivate existing products, but also strengthen our development capability for high-value-added products with digital control added to power and analog products."

www.rohm.com

General Manager & Vice President EMEA appointed

SCHURTER welcomes Steffen Lindner to its leadership team. As of April 1, 2024, he has taken over the newly created position of General Manager & Vice President EMEA. In this role, Steffen Lindner will be responsible for all company activities in EMEA, including product management, engineering, sales, and production. After completing his education as a radio and television technician and earning a graduate degree in electrical engineering / communications engineering, Steffen Lindner began his career in sales at Phoenix Contact. After two decades at Phoenix Contact, Steffen Lindner took over sales for Europe, Middle East and Africa at TE Connectivity Industrial. He adapted the sales organization to the changing market conditions and customer needs and introduced a potential-oriented market approach. By strategically focusing on key customers in specific application areas and working in partnership with distributors, Steffen Lindner was able to achieve above-average growth with the new organization. During his almost seven years at TE Connectivity Industrial, he was involved in several company acquisitions and their integration processes.

www.schurter.com

Global Distribution Agreement with Power Solutions Company

Mouser Electronics announced a global distribution agreement with Vox Power, a manufacturer of AC/DC power supplies and DC/DC converters. As part of this agreement, Mouser Electronics will distribute Vox Power's configurable, and rugged fanless conduction-cooled power supplies. These products have been specifically designed for the medical, industrial, and technology markets, providing high-density solutions that fit into compact spaces for demanding applications that conventional products cannot meet. The NEVO+600 modular configurable power supply, available from Mouser, is said to be the smallest in its class and "the ultimate solution for demanding applications where size, power density and weight matter".

www.mouser.com

Potential for SiC Replacement: Patents for GaN-on-Si

5N+, a producer of specialty semiconductors and performance materials, announced that it is officially launching the commercialization rights for its portfolio of gallium nitride on silicon (GaN-on-Si) patents. These key patents can enable the rapid prototype development and first-to-market commercialization of vertical GaN-on-Si power devices by companies operating in the High-Power Electronics (HPE), Electric Vehicles (EV) and Artificial Intelligence (AI) server sectors.

Today, lateral GaN is primarily used in low voltage (<400 V) applications, such as chargers, but vertical GaN-on-Si has the potential to replace SiC, which is the current preferred material for medium and high voltage applications (i.e. EV inverters operating 650 V). SiC is expensive and not easily available, whereas GaN-on-Si is more efficient and cost-effective. Recent academic demonstrations utilizing key 5N+ patents have shown that vertical GaN-on-Si, as opposed to lateral GaN transistors showing destructive breakdown, offers soft breakdown with avalanche capability for safe, compact and more efficient devices.

The commercial rights of the 54 granted patents owned by 5N+ include mandatory use of large diameter thick silicon substrates (over 1 mm), combined with masking layers to filter the dislocations. Increasing the thickness of large diameter silicon substrates in vertical GaN-on-Si devices enables increased voltage capacity without increasing the chip size. Also included in this patent is the ability to remove the substrate to form the backside contacts once the GaN growth is complete.

www.5nplus.com

Opening of Manufacturing and After-Sales Support Facility in Thailand

Recom has recently established its new manufacturing and after-sales support setup in Bangkok, Thailand. The initiative aims to enhance service quality for the global market and the local customer base, as well as to minimize supply chain risks for international clients. Claimed to set new standards in manufacturing, quality control, and after-sales services, the facility is said to represent "a significant advancement in Recom's operational capabilities". It also houses a logistics center designed to ensure efficient, on-time deliveries to both regional hubs and customers worldwide. Central to the new setup is a commitment to sustainability. Optimizing the supply chain, manufacturing processes, and transportation methods, the facility significantly reduces energy consumption. These efforts mark a major step in Recom's journey towards complete sustainability and achieving zero emissions across the full value chain. In 2024, the focus is on reaching a significant milestone: Recom Thailand is set to ship over 1 million pieces of a wide range of low- and high-power products, from 1 W to 2 kW, catering to the global market.

www.recom-power.com

Trade Show in Kuala Lumpur, Malaysia: Doubling Participation

With the Southeast Asia semiconductor sector attracting growing worldwide investments as more regions diversify their supply chains, the stage is set for SEMICON Southeast Asia 2024 as visionaries and experts gather May 28-30, 2024 at MITEC in Kuala Lumpur, Malaysia for insights into the latest industry developments, trends and innovations and critical areas including sustainability, smart manufacturing, and workforce development. Themed Boosting Agility and Resiliency of the Global Electronics Supply Chain, SEMICON Southeast Asia 2024 will feature more than 500 exhibiting companies and more than 1,000 booths, doubling participation from last year's exhibition and conference. The exponential expansion underscores the rising interest in Southeast Asia's semiconductor sector and the increasing importance of SEMICON Southeast Asia, the region's premier global electronics manufacturing and supply chain event, in bringing industry stakeholders together to pursue new innovation and growth opportunities. For example, there will regional pavilions from semiconductor regions such as China, Europe, Malaysia, Netherlands, Korea, Singapore, Taiwan and Southeast Asia. Several forums will focus on market and industry trends, sustainability, chiplet and heterogeneous integration, advanced product testing and more. In industry gala night will enable the attendees to connect and to expand their business network.

www.semiconsea.org

Trade Show about EMC Components, Testing and Shielding

The EMV achieved an impressive response in Cologne from March 12 - 14, 2024. The trade fair, accompanied by a scientific conference with workshops, featured 111 national and international exhibitors from 20 countries. Key players such as Rohde & Schwarz, Frankonia and EMC Test NRW as well as 21 companies, taking part in the EMV for the first time, were also present. More than 2,500 trade visitors – including the editorial team of Bodo's Power Systems – took the opportunity to find out about the industry's entire range of topics: from filters and filter components to EMC testing and shielding including its latest developments. A lively exchange of specialist knowledge was also high on the agenda in Cologne. Current trends this time around included EMC in electromobility, smart technologies, power electronics and the use of artificial intelligence in EMC. Parallel to the trade fair, the EMV Conference offered an extensive program with 49 conference lectures, 24 workshops and poster presentations held for the first time. The event demonstrated the growing importance of EMC in an increasingly networked world. In view of the growing number of potential sources of interference and even more complex systems, it has become clear that awareness of EMC issues is steadily rising. More than 700 conference bookings illustrated the high level of interest in the event. The next EMV event will take place from 25 - 27.3.2025 in Stuttgart.

www.mesago.com

Conference on Topics around Electric Drives Production

The Electric Drives Production Conference (E|DPC) 2024 is a platform for the exchange of developers, researchers and users of

electric drives. Now the call for papers is open to present the latest technical expertise in front of professionals from science and industry. The E|DPC will take place as a hybrid event from November 26 to 27, 2024 at the marinaforum Regensburg and online. Key topics include electric machine design, power electronics and control methods, new materials and semi-finished products, magnet materials and processing, manufacturing technologies for soft magnetic materials, winding technologies, insulation technologies, assembly and handling technologies, electric drive production systems, production of electrical actuators, industry 4.0 applications in electric drives production, sustainability in product lifecycle, new applications for electric drives, electromobility, electric drive specific testing, accompanying economic research, additive manufacturing, energy transfer for electric vehicles and interconnecting technologies.

www.edpc.eu

Akquisition of Industrial Drive Technology Company

Siemens has signed an agreement to acquire the industrial drive technology (IDT) business of ebm-papst. The business, which employs around 650 people, includes intelligent, integrated mechatronic systems in the protective extra-low voltage range and innovative motion control systems. These systems are used in free-range driverless transport systems. The transaction is to be completed by mid-2025, subject to the necessary foreign trade and merger control approvals. The IDT business of ebm-papst is located in St. Georgen, Germany and Lauf an der Pegnitz, Germany, as well as in Oradea, Romania.

www.siemens.com

Managing Director of Power Company

TDK Corporation announces the appointment of Christopher Haas as Managing Director at TDK-Lambda Germany from 1st April 2024. Christopher has been a member of the Board of Directors since 2012 and will retain his previous duties heading the Quality & Compliance organisation within the EMEA region in his new role. With over 20 years of experience working in the electronics industry, Christopher brings a comprehensive portfolio of technical knowledge, as well as an enterprising skill set, holding

an Executive Master's in International Business. Christopher succeeds Gustav Erl, who will retire on 30th June 2024, after 38 years of seniority. In his new role, Christopher intends to lead the organisation with a vision of sustainable and future-oriented growth, building on the company's foundation and values.

www.emea.lambda.tdk.com

Taiwanese Company opens Office in Japan

The Taiwanese MOSFET manufacturer PANJIT has officially opened its Japan branch in Tokyo. This is a significant milestone and it shows PANJIT's dedication to global expansion and its commitment to serving the Japanese market. The Japan branch will serve as a key hub in Asia, enhancing service efficiency and improving communication with Japanese clients. This initiative aims to provide tailored solutions and localized support.

At the opening ceremony, Jason Fang, President of the PANJIT Group, highlighted the significance of the Japan office: "The establishment of our Japan branch is central to our global ambitions and our dedication to the Japanese market. We are committed to delivering prompt, tailored service to ensure our Japanese customers feel highly valued and supported."

www.panjit.com.tw

Power Seminar in German Language

Targeting Hardware-/Software design engineers, product development, business development and key accounts Mankel Engineering is organizing a hands-on-oriented user symposium about motors and inverters of xEVs. The seminar, which will take place at the end of June 2024 in northwestern Germany, can only be attended with physical presence, and the conference language is German. After an introduction about electrical motors the main focus will be on the components of a power inverter.

www.mankel-engineering.de

Factory in Monterrey to open this Year

Rogers Corporation announced that it has signed a lease on a factory in Monterrey, Mexico for advanced busbar manufacturing and engineering services. The first phase of the new site is slated for completion in late 2024 and continues Rogers' manufacturing footprint strategy of supporting customers in the regions where they operate. Rogers' Rolinx busbars provide power distribution in a variety of applications in the electric and hybrid-electric vehicle (EV/HEV), renewable energy, mass transit and industrial markets. "We are excited to expand our presence in North America to better support our global customers and the growing EV/HEV and renewable energy markets in this region. Our new factory in Monterrey will enable us to better support our customers with deeper technical collaboration, and local prototyping and supply capabilities that reduce lead times and improve service levels," said Jeff Tsao, Advanced Electronics Solutions (AES) Senior Vice President and General Manager.

ROGERS CORPORATION

www.rogerscorp.com

PCIM Europe 2024: Conference and Trade Show

PCIM Europe is probably the leading international exhibition and conference for power electronics in Europe. What can attendees expect when they travel to Nuremberg from June 11 – 13?

PCIM is both – a conference and a trade show. At the conference there will be around 500 presentations, and on 38.000+ square meters of show floor more than 600 exhibitors will showcase their products. Mesago, the organizer of the show, points out that the number of exhibitors has increased by more than 100 compared to PCIM 2023. Of these, 60% are international representing a total of 33 countries. Exhibitors include companies such as Efficient Power Conversion (EPC) Corporation, Fuji Electric Europe, Infineon Technologies, Mitsubishi Electric Europe, onsemi, SEMIKRON Danfoss, ROHM Semiconductor, STMicroelectronics, Volkswagen and Wolfspeed.

Technology Stage and more

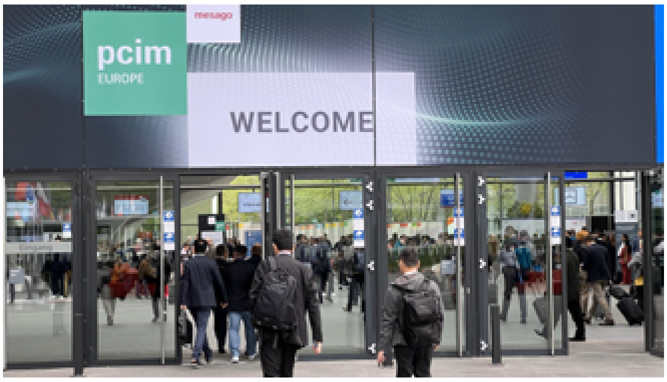
Within the exhibition halls there are four stages where presentations will highlight the latest products, developments and trends in the industry. For example, on the Technology Stage in hall #7 Bodo's Power Systems will be gathering the major players of the wide bandgap industry where they will provide a highly-compact overview of the latest SiC and GaN development in a nutshell. Our Viewpoint on page 4 explains, how this "speeddating"-like happening works. Other presentations will complement the Technology Stage program.

In hall #5, the new Smart Power System Integration Stage covers solutions and application examples for the challenges in power electronics production – from Smart Power Embedding to Integrated Smart Power Circuits.

Product innovations and solutions from exhibiting companies, including onsemi and Nexperia, will be highlighted on the Exhibitor Stage in hall #9. The presentations on the E-Mobility & Energy Storage Stage in hall #6 will shed light on current and future developments in power electronics for electromobility and energy storage. In addition, a networking area invites visitors to engage in intensive discussions.

University Research Zone

At the new University Research Zone in hall #7, different national and international universities and institutes will provide an in-depth daily insight into the power electronics research landscape. Current research projects will be presented by the Technical University of Denmark, the Bundeswehr University Germany and RWTH Aachen University, among others. This University Research Zone is a kind of tabletop exhibition at a top location close to major exhibitors like Infineon and Vincotech. In this zone, universities have to pay less than 400 Euros for one day, and every day there will be other universities presenting their projects.



PCIM Conference

At the PCIM conference every day will start with a keynote speech. Rolf Hellinger, Head of Company Core Technology and Center of Competence Power Electronics at Siemens AG, will begin with the first keynote of the conference on the topic of "AI between Hype and Industrial-Grade". On the second day of the conference, Martin Wietschel, Head of Competence Center Energy Technology and Energy Systems at Fraunhofer ISI, will speak about "Infrastructure Requirements for Electrified Heavy Goods Transport in Germany and the EU", and on day 3 the keynote speech will be given by Gerald Deboy, Fellow of Infineon Technologies Austria, who will highlight "Challenges and Solutions to Power Latest Processor Generations for Hyper Scale Datacenter".

Seminars

On the two days prior to the PCIM Europe 2024 exhibition and conference, half-day seminars at the near Arvena Hotel will offer an opportunity for direct exchange between seminar instructors and participants. The interactive sessions reflect a variety of topics in power electronics. Every seminar can be individually booked

Digital Event Platform

Furthermore, the digital event platform PCIM Europe digital offers the opportunity to discover presentations from the conference and the stages at the exhibition and gain extensive information and specialist knowledge regardless of time and location. All oral presentations at the conference will be streamed live and will be available on demand on the digital platform afterwards – with the exception of the poster presentations. In addition, the contents from the Technology, Exhibitor, E-Mobility & Energy Storage and Smart Power System Integration Stages will be represented afterwards in the media library. The exhibiting companies will also be on the digital platform with their company and product profiles.

https://pcim.mesago.com

Exhibition spreading from Coil-Winding to e-Mobility

Taking place from May 14-16 2024, this CWIEME Berlin exhibition will see leading professionals come together to discuss and showcase innovative products from the coil winding, transformer, generator, electric motor manufacturing and e-mobility sectors. For 2024, the event has secured many industry professionals to participate in sessions and talks that will discuss latest innovations, technologies and key issues in the electrical engineering industry. Confirmed speakers include representatives from The International Copper Association, Syensqo, S&P Global Mobility, Siemens Energy, Thyssenkrupp Steel Europe, Hitachi Energy, SGB-SMIT GmbH, STILRIDE, Mckinsey Center for Future Mobility and Ford Europe. The central stage will cover a host of topics such as innovation in transformers oils, driving sustainability in the manufacturing and energy sectors with a deep dive into eco-friendly practices in the steel industry, and a panel discussion on what the future holds for rare earth materials. The e-mobility stage will host talks including a keynote speech on decarbonisation in the automotive sector, a session on the importance of reliability for electric vehicle (EV) infrastructure, a panel discussion on the emerging trends, a talk on innovations and advancements in new motor technologies, and a session on how the automotive industry can remain competitive in the age of electrification.

https://berlin.cwiemeevents.com

Increasing power for faster EV charging times

With Infineon's new CoolSiC™ MOSFETs Generation 2 electric vehicles can be charged faster, contributing to the reduction of CO_2 emissions.

- **Reduced power losses:** The new CoolSiC™ MOSFETs G2 reduce power losses by up to 10 percent compared with the previous generation. This means that less energy is wasted during the charging process, leading to increased efficiency and reduced operational costs for EV charging stations
- **Higher charging power and faster charging times:** Despite the reduction in power losses, CoolSiC™ MOSFETs G2 allow for higher charging power without expanding the physical size of the charging station. This means that EV owners can benefit not only from higher efficiencies but also from faster charging times without the need for significantly larger or more complex infrastructure

Improved chip performance and FOMs

Improved .XT package interconnect

Best-in-class $R_{DS(on)}$ and the most granular portfolio in the market

Learn more
www.infineon.com/coolsic-g2

Infineon

Powering Portable Electronics Using High-Voltage MCUs with Integrated Buck-Boost Battery Charge Controllers

By Anand Kannan, Product Marketing Manager, Infineon Technologies

USB Type-C has become the port of choice for powering portable electronics worldwide. As more and more products adopt USB-C as their charging port, the need for integrated USB-C PD controllers is growing in the market. A device powered by USB-C port should support at least 5 V at 3 A (15 W), but ideally featuring USB-C Power Delivery (PD) with standard power range (SPR). This allows the eco-system to support several power levels up to a maximum of 20 V at 5 A (100 W). USB-C PD with extended power range (EPR) allows the system to support several power levels up to 48 V and 5 A (240 W).

Infineon's new EZ-PD™ PMG1-B1 is the industry's first high-voltage microcontroller with an integrated buck-boost battery charge controller. Portable electronic systems powered by USB-C PD use a USB PD controller and a buck-boost battery charging controller to charge the battery and power other electronics. In addition, the controller also provides overvoltage, overcurrent, undervoltage, and short-circuit protection.

PMG1-B1 is a highly integrated USB Type-C PD MCU with integrated buck-boost battery charge controllers. It complies with the latest USB Type-C and PD 3.1 specifications. PMG1-B1 has a 32-bit Arm® Cortex®-M0 processor on-chip, 128 KB flash, 16 KB RAM, and 32 KB ROM. It also has integrated gate drivers for VBUS NFET on the consumer path for sink applications. PMG1-B1 also includes hardware-controlled protection features on the VBUS and supports a wide input voltage range (4 V to 24 V with 40 V tolerance). It also provides switching frequency programming between 150 to 600 kHz enabling 2–5 cell battery charging in an integrated USB-C PD high-voltage MCU solution.

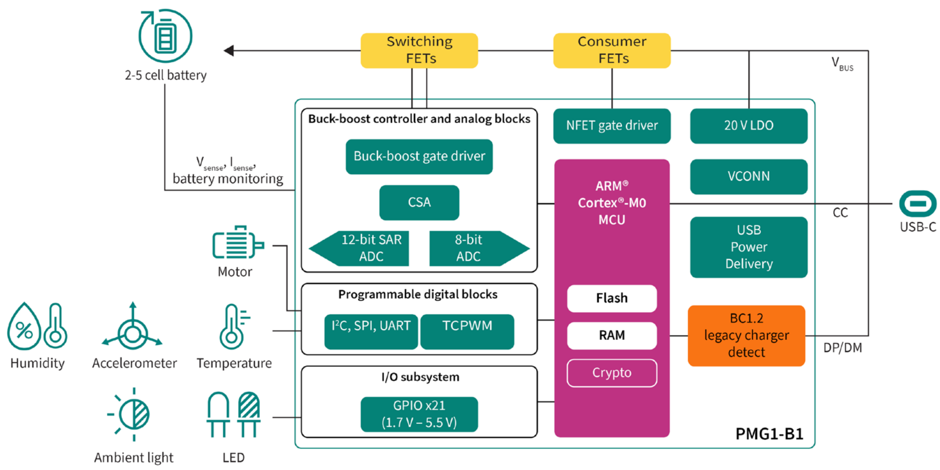


Figure 1: PMG1-B1 as a system MCU and buck-boost battery charge controller for 2-5 cell battery-powered applications

EVAL_PMG1_B1_DRP is the evaluation kit for the EZ-PD PMG1-B1 USB power delivery (PD) microcontroller (MCU) with an integrated buck-boost battery charger. EZ-PD PMG1-B1 is targeted for battery-powered applications that are powered by USB-C PD.

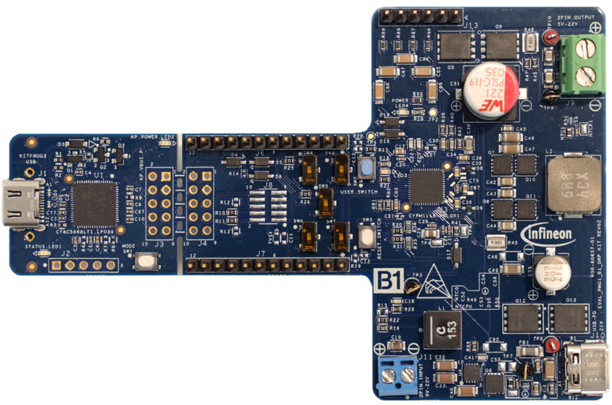


Figure 2: PMG1-B1 as a system MCU and buck-boost battery charge controller for 2-5 cell battery-powered applications

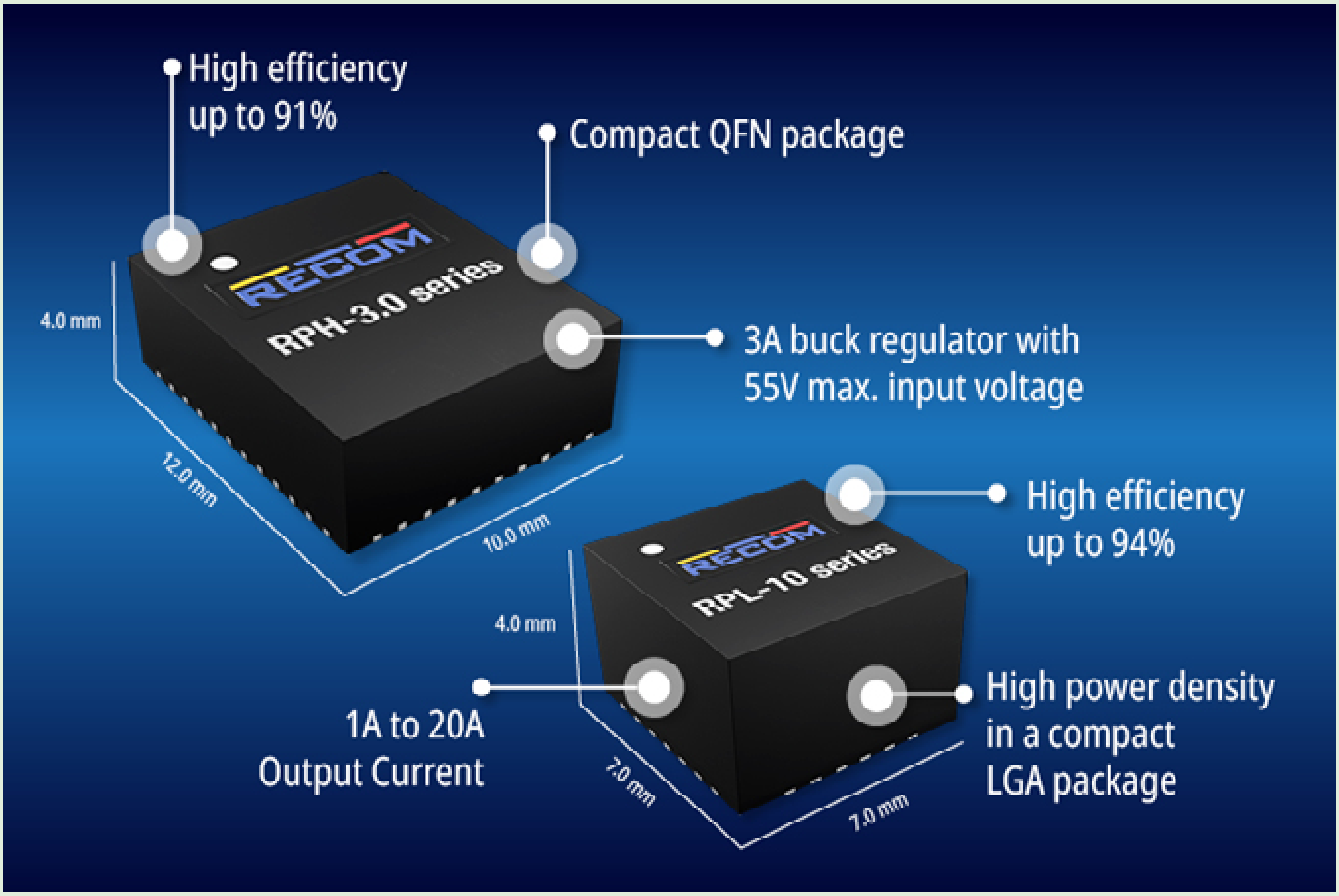
The kit is used to sink up to 100 W (20 V, 5 A) and source up to 27 W (9 V, 3 A) of power. The kit can also be used to charge 2–5 cell batteries, and the battery charging algorithm is implemented as part of PMG1-B1 SDK. The kit along with the SDK make it simple for developers to create their applications for the microcontroller. The USB-C PD and battery charging (2S-5S) code is readily available in ModusToolbox™ as part of PMG1-B1 SDK and developers can build on top of the existing project. The kits are readily available on the Infineon website as well as with Infineon's distributor partners.

A reference schematic and layout is available for customers who want to enable 100 W (20 V, 5 A) DRP role, i.e., source and sink 100 W using EZ-PD PMG1-B1. Infineon's systems team has added additional code examples to the PMG1 SDK to support both brushed and brushless DC motor control using EZ-PD PMG1 MCUs. Go to our community for information and expert exchange on PMG1 high-voltage microcontrollers.

Download the user manual of EVAL_PMG1_B1_DRP – click here.

www.infineon.com

Tiny Encapsulated Buck Regulators Supply up to 20 A with up to 94 % Efficiency



RECOM now offers a range of four encapsulated buck regulators in ultra-compact, thermally enhanced LGA and QFN packages with output current ratings of 1, 3, 10, and 20 A for cost-sensible markets. The first product, the RPL-1.0, comes in a 3 mm x 3 mm LGA footprint with a "height" of 2 mm and operates over an input range of 3 to 22 V with an adjustable output of 0.6 to 12 V. 1 A output will still be available when the ambient temperature exceeds 80 °C, depending on input/output voltage combinations with operation temperatures up to 125 °C ambient possible, however, with derating. Efficiency is up to 95%.

RPH-3.0 is integrated in a 47-pad QFN package measuring 10 mm x 12 mm x 4 mm height, and provides 3 A at the output over an input range of 4.5 to 55 V. Its adjustable output range spreads from 1 to 15 V. Efficiency is up to 91 %, and full output current can be delivered even at temperatures beyond 80 °C, for example at 12 Vin and 3.3 Vout.

The third device, RPL-10, is rated at 10 A output and offers several additional features. Integrated in an LGA-M package (7 mm x 7 mm x 4.4 mm) the regulator operates with input voltages between 4 and 16 V while the programmable output voltage can be in the range of 0.6 to 5.5 V. The maximum efficiency is specified with 94 % allowing operation at up to 90 °C at full load. The operating frequency may be selected between 600 kHz and 800 kHz, control is by constant on-time for fast transient response, and a pulse skipping mode maintains efficiency at light load.

Finally, the RPL-20 is claimed to take the "power density to a new level" with its 20 A rating from a programmable output of 0.6 to 5.5 V. Its input range spans from 4 to 16 V, and the maximum efficiency is 94 %, enabling operation at ambient temperatures up to 90 °C at full load. Its package has the same dimensions as the RPL-10 (7 mm x 7mm x 4.4 mm), which means that it effectively doubles the power density. The device operates with selectable frequencies between 600 kHz and 1 MHz, with forced continuous conduction and pulse skipping modes as selectable options.

All these components are equipped with integrated magnetics and include functionalities like remote on/off, a power good signal, and comprehensive protection against input under-voltage, over-temperature, short circuits, and output overload.

www.recom-power.com

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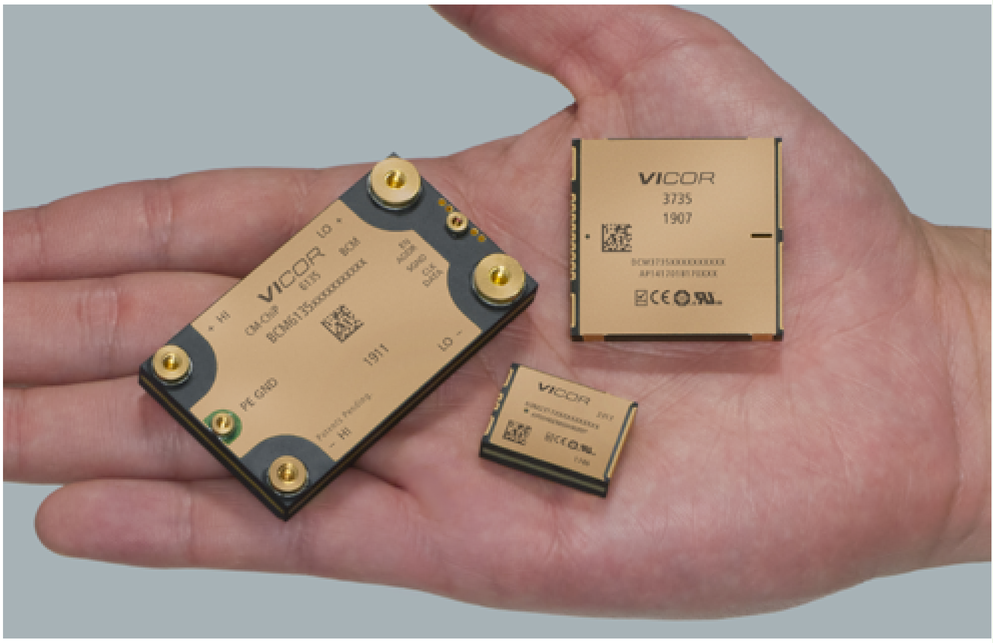
Modular Approach to 48V Automotive Power Delivery Networks

The Interview with Greg Green, Director Automotive Marketing, and Maury Wood, VP Strategic Marketing of Vicor Corporation was conducted by Roland R. Ackermann, Correspondent Editor



Roland: In the power supply sector, Vicor is known for its high density, high performance DC-DC power modules. What are the distinguishing features of these modules?

Greg: Since the company's inception almost 40 years ago, Vicor's constant focus has been on four pillars of innovation, power delivery architectures, power switching topologies, control systems, and packaging. Each of these elements plays a critical role in achieving the highest power density and current density by minimizing power losses within the module and in the power delivery network. For example, Vicor fixed ratio converters use a proprietary Sine Amplitude Converter (SAC) circuit topology with high frequency zero voltage switching and zero current switching to minimize conducted and radiated emissions at maximum power efficiency. Vicor recent advanced products are molded and plated. The molded construction ensures thermal adeptness, mechanical rigidity and environmental robustness across temperature, humidity, and vibration. The plated exterior enables high-yield surface-mount assembly, which provides an ideal thermal conductor for forced-air or liquid cooling using

Greg Green: "The 48V zonal architecture is a bridging approach to support the largely economically-driven transition from a total 12V PDN to a total 48V PDN."

Maury Wood: "Vicor products are distinctive for having the highest power density in broad DC-DC converter application market segments."

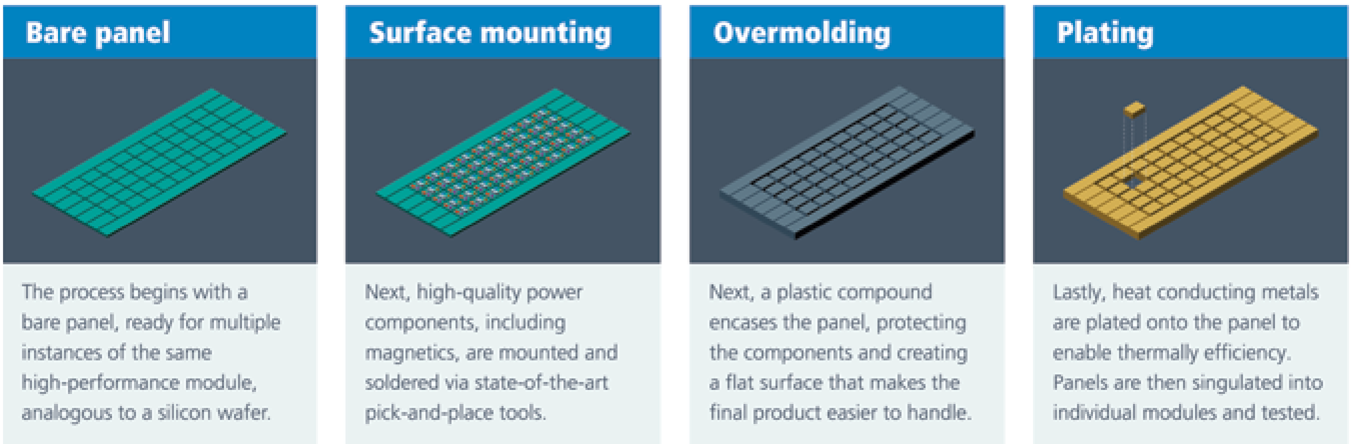


Figure 1: Chip manufacturing panel process: "Unique ChiP manufacturingoptimizes density, cost andquality"

cold plates.

Vicor products are distinctive for having the highest power density in broad DC-DC converter application market segments. For example, Vicor has recently begun sampling a 73.6cm2 sized module for automotive boost DC charging applications with an astounding power density of 672kW per liter.

What are the unique characteristics of power modules and what advantages are gained compared to conventional discrete solutions?

Greg: Vicor has invested in a new vertically-integrated, highly-automated factory in Andover, MA, USA, where numerous power modules are manufactured simultaneously on panels, in a process much like that used to fabricate semiconductor chips. State-of-the-art surface mount assembly methods, advanced package overmolding combined with unique module construction, and functional test methodologies have been developed over Vicor's 40-year history. A three dimensional intraconnect (3DI) is now performed on Vicor's advanced products within the new world-class environmentally-responsible Vicor manufacturing facility. Vicor refers to this complete set of manufacturing capabilities as "Converter housed in Package" or ChiP fabrication.

Vicor delivers complete DC-DC converter solutions with a range of PCB mounting options suitable for automotive applications, requiring a minimum of additional components for EMI filtering and telemetry communication.

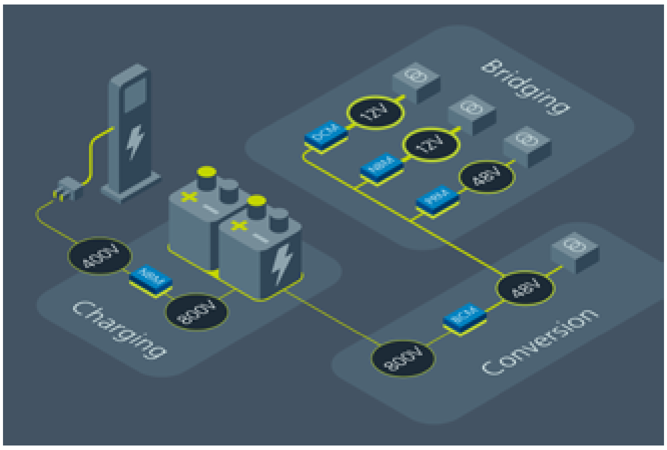


Figure 2: Automotive solutions combined

Many of the compact Vicor modules (including BCM bus converters, PRM regulators, and DCM DC-DC converters) are designed to work bidirectionally and in parallel arrays, for greater output power efficiency and capacity. This adds flexibility in the target system PCB layout, enabling the power architecture to be easily scaled up or down to match changes in power requirements. This capability also simplifies the system-level design and BOM cost. Furthermore, all DC-DC conversion functions and isolated magnetics reside within the modules, greatly simplifying the end application system design. The use of high frequency switching topologies plus zero voltage and current switching not only reduces power losses and increases density but also reduces electromagnetic emissions, cost reducing regulatory certification processes.

Where are Vicor modules preferably designed-in and used? Where and why have they proved successful so far?

Greg: Vicor products are used today in a broad range of end applications, including high-performance generative AI computing, industrial factory automation, and aerospace systems. Vicor entered the automotive segment about five years ago, bringing advanced modular power technologies to the rapidly electrifying automotive ecosystem. In the focus application areas, Vicor modules are used to create 12V power zones from 48V supplies, and to provide power conversion between 800VDC and 400VDC batteries and charging stations, creating legacy compatibility and future-proofing the on-vehicle Power Delivery Network (PDN).

Could you describe the anatomy of an automotive modular power delivery network?

Maury: In battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), the power network will typically use a series of modules to provide separated extra low voltage (SELV) power to loads throughout the vehicle. Often, a Vicor Bus Converter Module (BCM) will convert the battery high voltage, typically 800VDC, down to 48VDC, creating the baseline SELV for the vehicle PDN. The BCM also provides galvanic isolation internally, enabling a small DC-DC converter subsystem. If needed, the PDN will include a Power Regulation Module (PRM) to create a regulated 48VDC source, or a DC-DC Converter Module (DCM) to create a regulated 12VDC feed to legacy subsystems.

For hybrid electric vehicles, Vicor customers typically use PRMs and DCMs to manage a multiplicity of 12V and 48V loads.

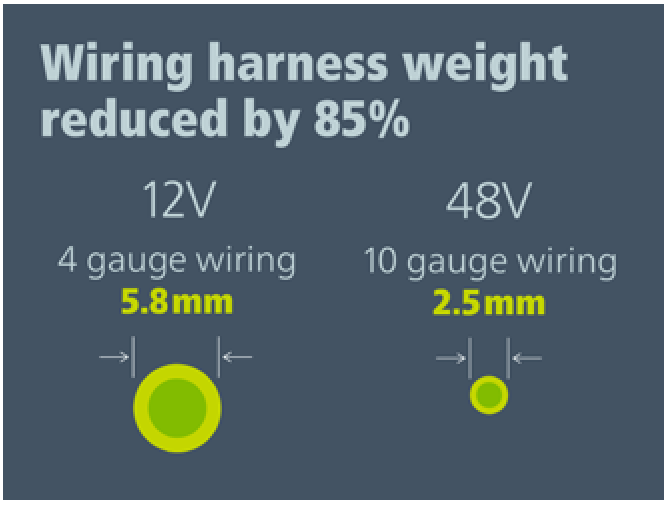


Figure 3: Automotive e-wiring harness comparison

Let´s go deeper into a specific application area of Vicor power modules. Vicor has years of experience in the automotive industry, and more recently in automotive high voltage power supply subsystems. There are certainly many important reasons for the development of 48V power supplies and buses. But what is the main reason that Vicor developed its 48V zonal architecture as an alternative to the traditional centralized architecture?

Greg: Vicor has been providing 48V power solutions for customers in applications outside of the automotive industry (such as in cloud computing rack applications) for many years. Automotive OEMs have been faced with the classic chicken or egg first dilemma for a long while in terms of transitioning vehicles to 48V. Obviously, the benefits of higher voltage, lower current power distribution are well known by electrical engineers. ICE vehicles continue to use long-proven and reliable 12V supply subsystems, and generally speaking, virtually all of the multitudinous vehicle loads are performance- and cost-optimized at 12V. BEVs and PHEVs provide a new and exciting opportunity to use a 48V PDN, but most existing loads today (for example, fans and heaters) are 12V peripheral devices.

The 48V zonal architecture is a bridging approach to support the largely economically-driven transition from a total 12V PDN to a total 48V PDN. It creates a 48VDC main (or backbone) PDN to achieve the immediate performance benefits of a 48V system, including lower wiring harness weight, cost, and PDN power losses, but then uses local 12V networks to support existing cost-optimized loads (e.g., window motors and lock actuators).

The 48V zonal architecture is scalable to meet changing end market requirements. On a typical vehicle, 15% to 20% of the low voltage subsystem loads use more than 80% of the available system power (e.g., power steering, active suspension, compressors, and pump subsystems). The zonal architecture allows OEMs and their suppliers to change out these heavy-hitters to 48V first, to recognize an immediate improvement in battery power allocation, efficiency, and weight/cost. The remaining "legacy" loads are placed in 12V zones, to change out over time as becomes economically practical.

This approach supports the reuse of new and existing designs across different vehicle platforms and platform derivatives. With power dense modules from Vicor, customers can convert more power in less space, preserving flexibility with respect to their physical placement within the vehicle.

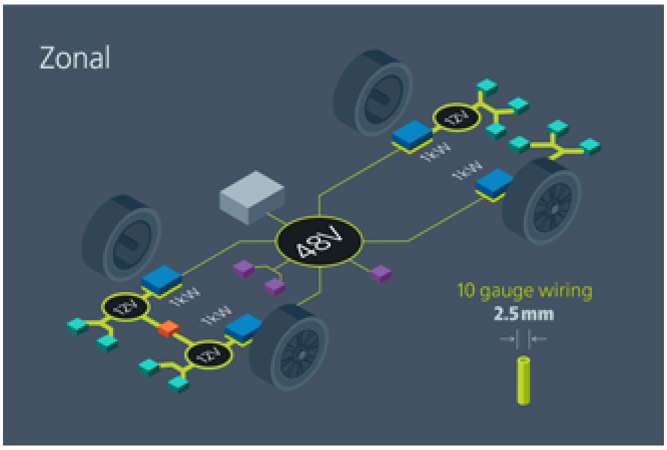


Figure 4: Automotive zonal architecture

Are you assisting industry engineers with designing their power supplies?

Maury: To meet today's demanding customer requirements, Vicor offers diverse and comprehensive products and services. Vicor application engineers work closely with customer product development engineers across the full product lifecycle process – definition, design, sampling, qualification, volume manufacturing, sustaining engineering – to ensure Vicor customers receive the most efficient, dense, flexible, and cost-effective power solutions.

What other merits do Vicor power modules offer?

Greg: The high voltage bus converter module or HV BCM6135 is a proprietary, ratiometric Sine Amplitude Converter (SAC) using a circuit topology to transfer energy from either 800V or 48V. It can start up from either 800V or 48V, providing full power. The BCM6135 has a PMBus feature enabling readout of the high voltage level to allow the application system to identify when precharge has been completed without any additional circuitry.

DCM, PRM, BCM, and high-voltage non-isolated bus converter (NBM) modules all provide PMBus communication which allows the supervisory microcontroller to monitor the power status and control the operation of the module.

The proprietary Sine Amplitude Converter (SAC) circuit topology does not require any output inductors and operates at a very high frequency. This allows for the transfer of current at an extremely high rate. The related figure of merit dI/dt (time rate of change of current) can be as high as an unprecedented 8,000,000 amperes per second. This allows vehicle designers to create a virtual battery to eliminate the low-voltage battery, saving weight, space, and cost.

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SiC MOSFET and .XT – Improved Lifetime for Your Applications

Infineon takes it up a notch in 2024 with its second-generation CoolSiC™ MOSFET devices. The recently launched SiC MOSFETs in the 650 V, 1200 V and 3300 V class under the well-known CoolSiC brand are targeting high voltage industrial applications such as EV charging, industrial solar inverters, servo drives, UPS, and railway traction.

By Tomislav Turšćak, Product Application Engineer, Giovanbattista Mattiussi, Director of Product Management, Syeda Qurat ul ain Akbar, Product Application Engineer, and Dr. Diana Car, Principal Technical Marketing Engineer, all Infineon Technologies

For low voltage applications such as power factor correction for servers, multilevel solar topologies, and high-power drives, Infineon will soon release a 400 V SiC MOSFET with channel resistance ranging from 11 mΩ to 45 mΩ, in two different 4-pin packages – TOLL and D2PAK-7. In this article, we cover the features of these high-voltage SiC power devices built with .XT technology.

An overview of the new, industrial grade CoolSiC MOSFET 650 V discrete

Infineon's latest 650 V discrete MOSFET is based on second generation (G2) SiC trench technology. The first generation (G1) CoolSiC trench focused on providing reliable performance and implementing an industry-leading trade-off between performance and reliability – characteristics that helped develop customers' trust in the novel SiC technology. G2 builds on this by adding better performance, more usage flexibility, and advanced packaging technology, while maintaining G1's reliability and robustness with respect to the gate oxide layer (GoX). The switching behavior of Infineon's second-generation SiC MOSFETs is compelling. The figure of merits (FOM) graphs, shown in Figure 1, highlight a marked improvement over the previous generation.

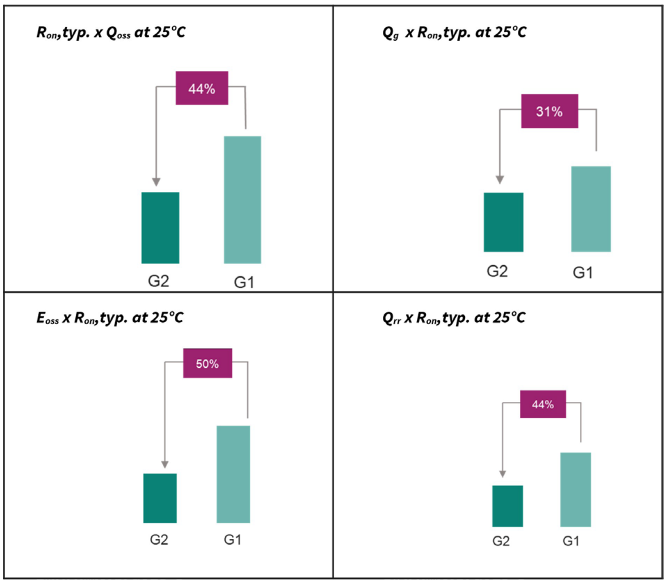

Figure 1: Figure of merits for MOSFETs of the new G2 technology compared to G1

The strong FOMs suggest that the G2 SiC MOSFETs from Infineon can successfully fit in high frequency designs, typical for soft switching topologies. Overall, they enable higher system power density. Interestingly, the improvement in switching performance in CoolSiC G2 balances the increase in thermal coefficient. Figure 2 shows the temperature dependence of R_{on}, at 25°C, in different Infineon 650 V power device technologies and generations. At 125°C, the CoolSiC G2 shows a 12 percent increase in R_{on} compared to G1. However, it stays below CoolGaN™ G1 and CoolMOS™ 7 by a minimum margin of 20 percent.

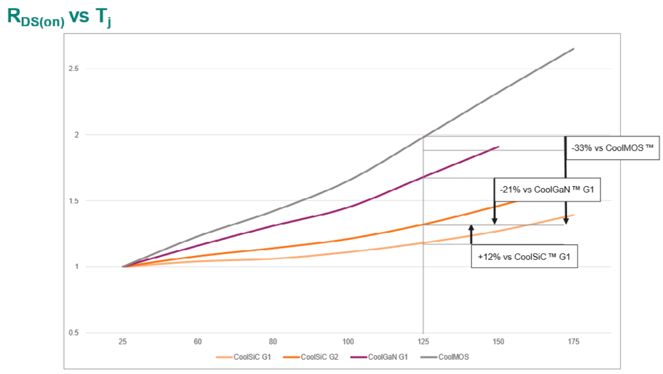

Figure 2: Temperature dependence of device resistance in different technologies

Stronger temperature dependency of device resistance does not impact the overall performance of the CoolSiC MOSFET 650 V G2, especially when assessed at the system level. System losses are generally the sum of conduction and switching losses. Conduction losses are mostly related to R_{on}, but switching losses depend on different parameters. The optimal switching behavior of the CoolSiC MOSFET G2 helps offset the more pronounced increase in R_{on} with temperature. It enables G2 to perform excellently, reaching a solid peak efficiency of 99.2 percent in the 3.3 kW continuous conduction mode totem (CCM) pole PFC measurements, as shown in Figure 3.

Apart from performance, CoolSiC G2 also makes designing easier, providing a wide range of driving voltages, from -7 V to 23 V, with excellent support for 0 V turn-off, which is possible because the parasitic turn-on effect has been reduced to negligible levels. The 0 V turn-off provides the possibility of simplifying the gate driving schema, using a unipolar design, which ensures compatibility with silicon-based super junction MOSFETs.

Another common customer pain point has been system reliability, especially in industrial applications where high availability and low maintenance costs are strong requirements. From the reliability point of view, the second-generation CoolSiC MOSFETs are best in class, leveraging the best possible gate oxide ruggedness among all SiC MOSFET alternatives in the market and an improved cosmic ray robustness.

Some distinctive aspects of the second-generation CoolSiC technology are further enhanced by advanced packaging technologies. For instance, all discrete G2 products use the .XT interconnection – a

proprietary die attach technique capable of reducing the device's thermal resistance ($R_{th,j-c}$). By mid-2024, the CoolSiC portfolio will be complemented by the top-side cooling package (TOLT).Top-side cooled SMD discrete MOSFETs combine the advantages of the TO and SMD packages – enhancing power density, reducing assembly costs, and allowing newer and more efficient designs.

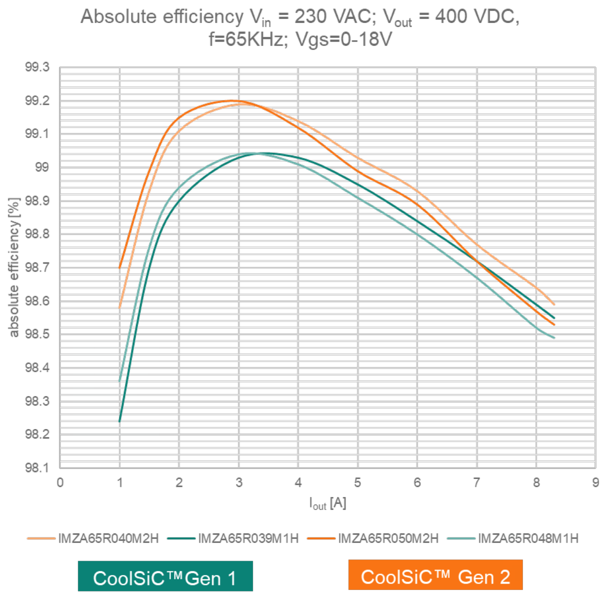

Figure 3: Comparing efficiency between G1 and G2 SiC MOSFETs

To extend the portfolio further, Infineon is also working to release the second-generation 650 V technology in a specific 8x8 package called ThinTOLL, which, while offering full compatibility with any 8x8, provides four times better thermal cycles on board (TCoB) capability than a standard 8x8.

In summary, the new 650 V voltage class will leverage the performance, ease of use, and reliability of the second-generation CoolSiC MOSFETs through a granular and evolving product portfolio, based on advanced packaging technology that will further enhance the G2 advantages.

.XT and 200°C capability of the 1200 V MOSFET family

Infineon's .XT chip interconnection technology enables smaller form factors while providing excellent thermal performance. The new CoolSiC MOSFET 1200 V G2 with .XT provides 12 percent better junction-to-case thermal resistance due to its improved die attachment process, as shown in the Figure 4. As a result, higher output currents and a longer device lifetime can be facilitated. The .XT technology employs the diffusion soldering method to minimize connection voids and reduce the thickness of the die attach layer.

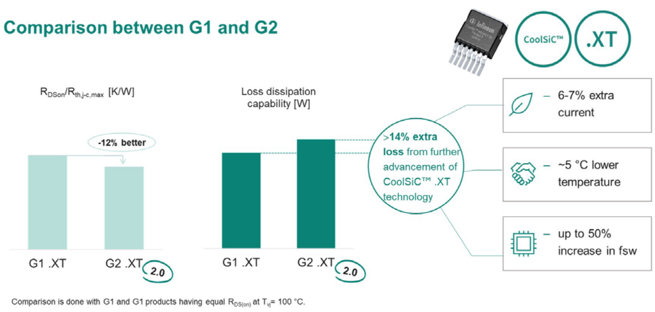

Figure 4: Reduced device thermal resistance due to improved die attachment process

SiC MOSFETs are known for their ability to operate at higher temperatures compared to traditional silicon-based MOSFETs. While the specific temperature ratings can vary between different SiC MOSFET technologies and manufacturers, most SiC MOSFETs are designed to operate reliably at junction temperatures of up to 175°C. Infineon's CoolSiC MOSFET 1200 V G2 is qualified to operate at up to 200°C for a total cumulative time of 100 hours. This device specification has been introduced to allow more reliability under overload conditions and offer engineers more freedom with system design. The ability of SiC MOSFETs to withstand short overload conditions is an important consideration in various applications. In industrial motor drives, sudden load changes, additional torque demand, or even power supply fluctuations can lead to overload conditions where the higher junction temperature margin is useful. Solar inverters and grid-tied applications are other good examples to demonstrate overload conditions because grid voltage fluctuations can impact the operation of the power converters. Voltage sags can influence the output power of the converter and temporarily increase power losses or, in severe cases, completely disconnect the system from the grid. In electric vehicle charging applications, the charger's voltage fluctuations are critical. In the case of a drop in the input voltage, the current can increase temporarily, creating additional stress for the power device. Figure 5 shows an example of the extended current capability of an 8 mΩ device due to the higher temperature limit. The gray curve represents a

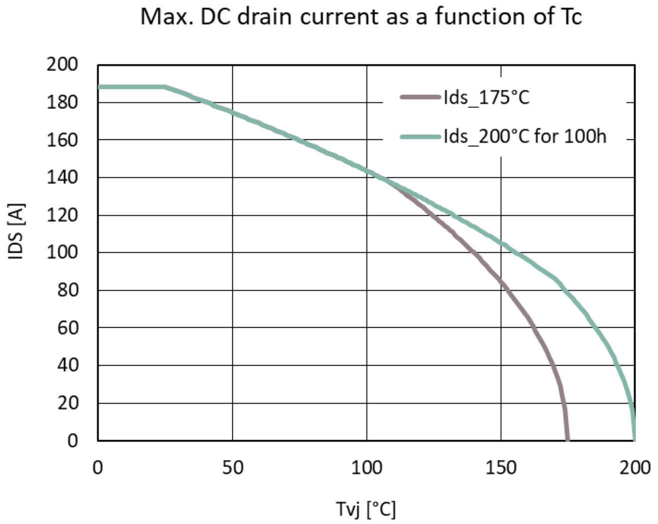

Figure 5: Device (IMBG120R008M2H) power dissipation at 200°C junction temperature

typical power semiconductor's, limited by a junction temperature of 175°C. In comparison, the green curve of CoolSiC G2 shows that more current is enabled at the same operating point, i.e., 150°C.

A detailed loss comparison of an G2 device, IMBG120R026M2H, and a G1 device, IMBG120R030M1H, under the same operating conditions, showed that the G2 device had 0.7 W (~3.5 percent) less conduction losses and 5.75 W (~23 percent) less total switching losses. Its overall operating junction temperature was also lower due to the combination of reduced losses and better $R_{th,j-c}$. [1]

Enabling shorter deadtimes for additional benefits

Today's MOSFETs are capable of switching in the range of tens of nanoseconds (ns). The switching energy curves available in the datasheets show that it is possible to achieve a significant reduction in device recovery losses and turn-on losses by reducing the deadtime of the driving voltage in the 3rd quadrant operation (time for the body diode to conduct before the channel is turned on). The recommended deadtime range is between 150 ns to 300 ns. By implementing the recommended values, turn-on losses can be reduced by 20 percent and recovery losses by 40 percent compared to nominal device values.

The deadtime limit depends on multiple factors such as the parasitics in the device and circuit, the speed of the gate driver, and the switched current level. Replacing a CoolSiC MOSFET G1 with the best matching G2 device allows for a 30 percent reduction in the required deadtime due to improved parasitic capacitance of the switch. This provides a wider margin for designing even in the case of a simple plug-and-play MOSFET replacement.

System benefits of a 2 kV discrete CoolSiC MOSFET

The new 2 kV discrete CoolSiC MOSFET enables the development of more efficient, cost-effective, and simplified designs for energy storage and photovoltaic systems – addressing the growing need for higher DC link voltage in these applications.

To increase power levels, photovoltaic systems are transitioning towards higher system voltages – 1500 V_{DC} being increasingly popular. This shift aims at reducing both power loss and system costs, making renewable energy more affordable.

Two options are available while designing a solar inverter with 1500 V at the DC link. The first option involves using a 3-level booster for the DC-DC maximum power point tracking (MPPT) stage and a 3-level topology, such as active neutral-point clamped (ANPC), for the DC-AC stage. 1200 V class devices are used in both these stages to ensure a safe and reliable system design. However, this approach is comparatively more complex, and has a higher component count. The second option involves using a simplified 2-level topology with higher voltage class devices. This approach can, potentially, be more efficient depending on the performance of the semiconductor devices used. Designers generally choose discrete devices to optimize system costs, improve design flexibility, and to lower the overall cost of ownership.

The most commonly available discrete semiconductor devices in the highest voltage class, so far, are 1700 V devices. Although using 1700 V class MOSFETs in 1500 V solar inverter systems with a simplified 2-level topology may seem like a viable option, it is essential to consider the impact of cosmic radiation-induced failures. These failures increase drastically at blocking voltages exceeding 80 percent of the rated voltage [2]. Therefore, using 1700 V class MOSFETs in 1500 V solar inverter systems with 2-level topology can significantly increase their failure rate.

2 kV CoolSiC MOSFET

The design challenges and reliability concerns can be mitigated by Infineon's new CoolSiC MOSFET 2 kV in a discrete package. The performance and bill of materials of a solar inverter using 2 kV CoolSiC MOSFET and diode was compared with that of inverter designs that implemented 1200 V devices. System-level simulation results showed that a 2-level booster stage with a CoolSiC 2 kV had 20 percent lower losses than a 3-level booster stage implemented with 1200 V MOSFETs. Similarly, the 2-level DC-AC stage with CoolSiC 2 kV had 15 percent lower power loss than the 3-level ANPC stage implemented with 1200 V devices. A detailed analysis of simulation and measurement data will be presented in the paper "Performance Evaluation of CoolSiC 2 kV SiC MOSFET Discrete in 1500 V DC Link Systems" at PCIM 2024.

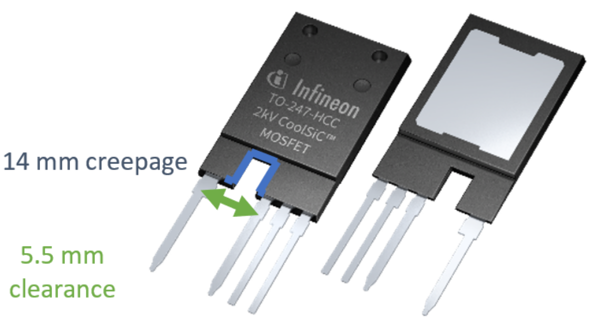

Figure 6: The new TO-247PLUS-4-HCC package

The new CoolSiC 2 kV comes in a new discrete TO-247PLUS-4-HCC high creepage and clearance package, shown in Figure 6, that ensures high-voltage insulation robustness and reliable operation. The product portfolio includes CoolSiC MOSFETs 2 kV [2] and Schottky diodes 2 kV with optimized switching performance and high blocking voltage, making it ideal for 1500 V_{DC} systems. These features of the new 2 kV MOSFET enable the development of simplified and reliable designs, making it an attractive solution for applications that demand high efficiency, low part count, and smaller system size and weight.

XHP™ 2 CoolSiC MOSFET 3.3 kV with .XT: Infineon's new high-power silicon carbide modules

Infineon is raising the bar in the field of power and technology with its two new 3.3 kV-rated silicon carbide (SiC) modules with robust .XT interconnection technology. These modules are designed to deliver high power (~1.5 MW) to applications with demanding mission profiles and challenging cycling requirements. The modules are:

- FF2000UXTR33T2M1: Room temperature on-state resistance of 1.9 mΩ and nominal current rating of 1000 A
- FF2600UXTR33T2M1: Room temperature on-state resistance of 2.5 mΩ and nominal current rating of 750 A

The 3.3 kV-rated CoolSiC MOSFET is optimized for fast switching with low oscillation tendency, which results in low total dynamic losses. The total dynamic loss at 150°C can be further reduced by ~ 30 percent by using XHP™ 2 CoolSiC MOSFET in the synchronous rectification mode and by optimizing deadtime. This means, reducing the time at the beginning and end of the freewheeling phase during which the load current is conducted through the integrated body diode [3]. The CoolSiC MOSFET 3.3 kV comes in the symmetrically designed and low-inductive (L_S = 10 nH) XHP 2 package to utilize fully the potential of fast-switching SiC MOSFETs in high-voltage and high-current applications.

To highlight the increased power density that the new SiC power module can deliver to traction converters, its performance was compared with the performance of the 3.3 kV IGBT IHV, which is still in use in many railway traction converters. Specifically, the performance of the 2-level, 3-phase motor inverter based on the 3.3 kV IGBT IHV solution (FZ2400R33H34) was compared with the performance of the 2-level, 3-phase motor inverter based on the new 3.3 kV SiC XHP 2 modules (two FF2000UXTR33T2M1 in parallel).

The comparison was done under the following conditions: 1800 V DC link voltage (VDC), power factor (pf) 0.9, modulation index (m) 0.9, and 60°C coolant temperature (Ta) of a water-cooled heatsink. In addition to an almost 50 percent lower footprint, the SiC-based solution provided 50 percent lower total losses, resulting in 50 percent more output current at the same switching frequency (1.5 kHz), or the same output current at a four times higher switching frequency (6 kHz instead of 1.5 kHz) [4].

The key features of XHP 2 CoolSiC MOSFET — lower losses, higher switching frequency, and higher power density — can be directly translated to multiple system benefits. Lower losses help save ~10 percent energy at the system level [5] and can enable simplified, quieter cooling systems. For example, by using passive motion cooling instead of forced air cooling. Operating the converters at higher switching frequencies results in lesser noise from the motor and allows for smaller size and lesser weight of the magnetic components. Higher power density helps reduce the converter volume by approximately 10 to 25 percent [6]. Reduction in system volume and weight is important, particularly in the case of hybrid-propulsion trains. Here, the additional space and reduced weight can be used to increase the size and, thus, capacity of the onboard traction batteries. Additionally, lower system weight and higher efficiency will allow better utilization of the available energy and help achieve the required driving ranges. Alternatively, if the required range is already achieved, lower system weight and higher efficiency will help in optimizing and reducing the cost of the installed traction battery, which is still very cost intensive.

Apart from high output power, many applications such as railway traction and wind power generation also require strong power cycling performance and longer device lifetimes. Due to the smaller chip sizes and specific material properties of silicon carbide (e.g., higher Young's modulus compared to silicon), it is more challenging to enable silicon carbide for such applications. Under cycling conditions, these factors result in greater thermomechanical stress on adjoining interconnecting layers, which can reduce the power cycling capability of the module [7].

Infineon's .XT technology can compensate for this effect by increasing the robustness of the interconnecting layers. XHP 2 CoolSiC MOSFET 3.3 kV with .XT has robust copper bond wires on the copper front-side metallization of the SiC chip, sintered chip on the substrate, and a highly reliable system solder. This boosts the cycling capability and the lifetime of the product, taking the SiC power cycling performance to the next level [8].

To illustrate the power of .XT, a lifetime simulation based on the exemplary mission profile of a line-converter in a regional hybrid-propulsion train was performed for SiC with standard joining technology (Al bond-wires, Al front-side metallization of the chip, chip solder, system solder) and SiC with .XT.

The simulation results showed that .XT extended the lifetime of the product by an order of magnitude — from ~4 years in the case of SiC with standard joining technology to ~40 years in the case of SiC with .XT. This demonstrates that .XT is crucial for enabling the full utilization of silicon carbide at higher junction temperatures. To achieve the required lifetime of 30 years in the case of SiC with standard joining technology, the maximum junction temperature during operation would have to be significantly reduced.

This means, a more cost intensive chip area would be needed to achieve the required output current. Due to the requirement for paralleling at the module level, this would also lead to increased complexity and costs.

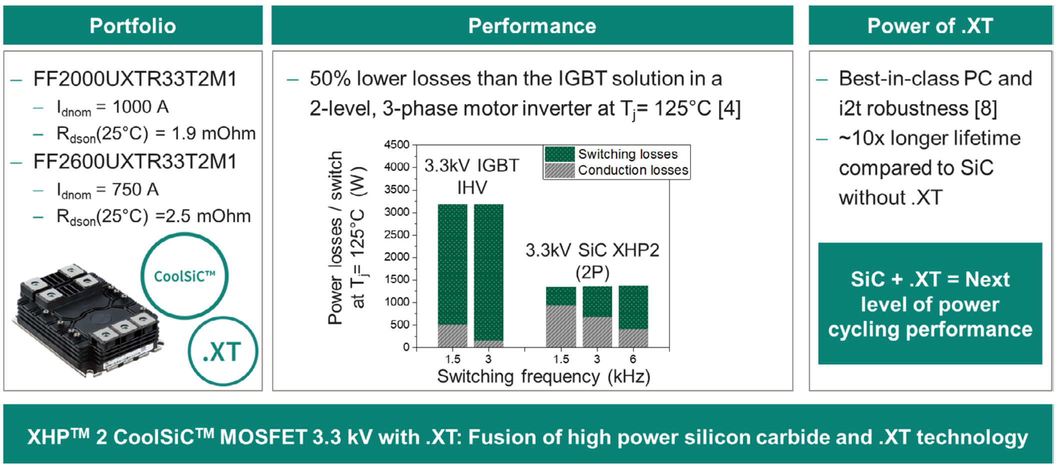

Figure 7: XHP™ 2 CoolSiC™ MOSFET 3.3 kV with .XT: Infineon's new high power silicon carbide power modules

In addition to providing the best-in-class cycling capability, benefits of .XT for XHP 2 CoolSiC MOSFET include high surge current robustness and short circuit withstand time [8]. This gives system designers more freedom in handling failure cases.

References

[1] Infineon application note: CoolSiC™1200 V Gen2 MOSFET in TO263-7 (D²PAK) package.

[2] G. Soelkner, et al., "Reliability of power electronic devices against cosmic radiation-induced failure", Microelectronics Reliability, 2004.

[3] M. Bürger, K.-H. Hoppe, K. Schraml, and A. Wedi, "The New XHP ™ 2 Module Using 3.3 kV CoolSiC™ MOSFET and .XT Technology, PCIM 2023, DOI: 10.30420/566091115.

[4] J. Vishal, J. Czichon, and M. Bürger, "Efficient an-dOptimized Traction Converter Systems Enabled by the New 3.3 kV CoolSiC™ MOSFET and .XT in an XHP™ 2 Package", PCIM 2023, DOI: 10.30420/566091119.

[5] https://press.siemens.com/global/en/pressrelease/sic-semi-conductor-technology-tram-siemens-mobility-and-stadtwerke-munchen-successfully

[6] https://www.mobility.siemens.com/global/en/company/stories/silicon-carbide-a-material-that-developers-dream-about.html

[7] P. Salmen and P. Friedrichs, "Qualifying a Silicon Carbide Power Module: Reliability Testing Beyond the Standards of Silicon Devices", CIPS 2022.

[8] M. Bürger and T.N. Wassermann, "Benefits of .XT for XHP™ 2 CoolSiC™MOSFET 3.3 kV" (to be published), PCIM 2024.

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Advancements in USB Power Delivery: GaN Technology for Efficiency and High-Power Density

The first Universal Serial Bus (USB) specification, released in 1996, aimed to standardize power delivery and connectivity in computing and telecommunication industries [1]. Initially supporting a 5 V power bus with up to 5 A of current (25 W) and maximum data transfer rates of 12 Mbit/s, USB has evolved significantly due to the proliferation of electronic devices, leading to a demand for higher power capabilities.

By Parinda Chantarasereekul, Application Engineer, and Alejandro Pozo Arribas, Senior Application Engineer, Efficient Power Conversion

Today, USB systems are used not only for data transfer and powering low consumption devices; they have become the solution for battery charging as well. Such evolution has been coordinated by the multiple revisions of the USB specification since 1996, with the latest major milestone being the USB Power Delivery (USB PD) Revision 3.1 update in 2021 [2]. This, combined with an upgrade to the USB connector, from the original Type-A to the newer Type-C, has set the path for over 10 Gbit/s data transfer and up to 240 W of power delivery. As shown in figure 1, the new USB PD 3.1 specification establishes a series of bus voltages to cover the different power levels. A maximum of 5 A over the cable and connector sets the power delivery limit at each voltage, thus increasing the voltage level remains the only way to increase power transfer.

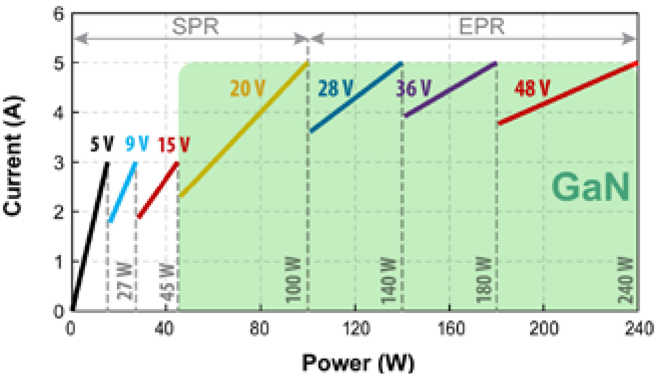


Figure 1: USB PD 3.1 specification: Power and current levels and corresponding bus voltages

Silicon-based products have been widely used to cover the Standard Power Range (SPR) due to the possibility of monolithic integration of the protocol IC, controller, and power devices, leading to reduced cost, complexity, and size [3]. However, silicon alone cannot achieve this level of integration, or the high efficiency needed to realize high power densities and low profiles over the entire Extended Power Range (EPR). Here is where GaN technology offers unmatched performance. The latest generation of 100V-rated eGaN® transistors have over 5x lower $R_{DS(on)}*Q_{OSS}$ and 2.5x lower $R_{DS(on)}*Q_G$ compared of their silicon counterparts [4]. Hence, converters can be made simultaneously more efficient and smaller.

Figure 2 shows simplified block diagrams of USB PD 3.1 systems where GaN is used in the power stage to cover the entire EPR. As shown, GaN technology can be deployed on both sides of the cable to create small and efficient USB PD solutions. First, on one side, a multiple port charger is pictured, where each port uses a regulated buck converter, fed from a common input, to provide the desired voltage on the USB cable. On the other side of the cable, GaN is featured in a buck converter to step the voltage down to 12 V or 20 V. This second application can be found in most laptops or other battery-power devices where the output voltage is set by the device's battery voltage.

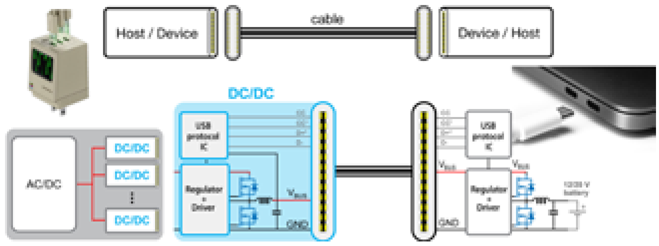


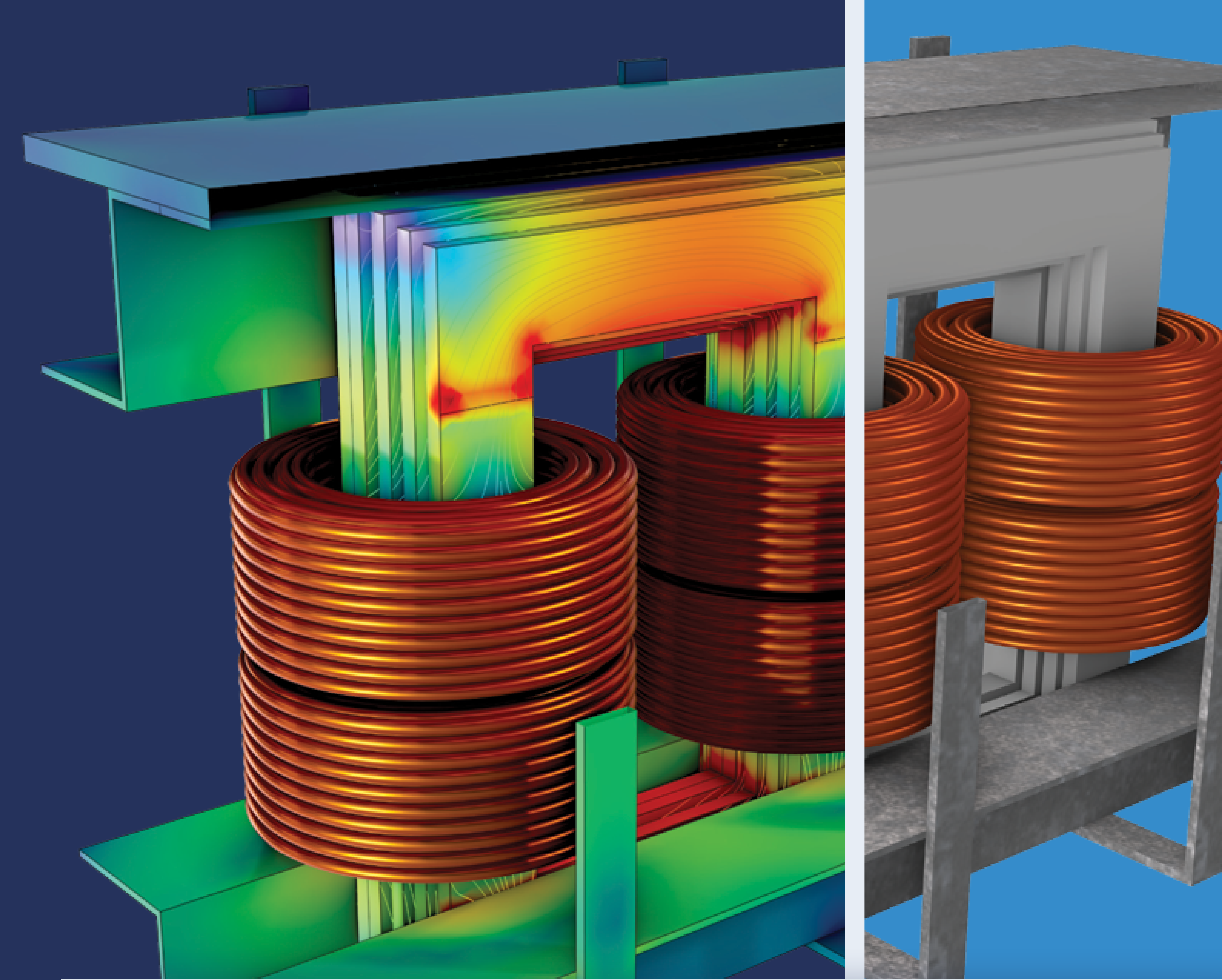
Figure 2: USB PD block diagrams using GaN devices

This article presents an example to illustrate the advantages of GaN technology for USB PD applications. It is based on EPC's recently released reference design, EPC9195 [6], which could be used as a battery charger. The design features a regulated buck converter using GaN transistors in combination with an analog controller [5] and it demonstrates how to unlock very high-power densities while delivering up to 240 W to a load from a 48 V bus in a very simple implementation. The article continues with a brief overview of the converter and a description of its key components, followed by the design validation results.

Converter Overview

The EPC9195 design utilizes a compact and efficient synchronous buck converter with a wide input voltage range from 20 V to 60 V capable of delivering up to 240 W to a regulated 13 V output, making it ideal for battery charger in a USB PD 3.1 compatible device.

The converter occupies a very small functional circuit area of 1025 mm^2 as shown in figure 3. Despite its small size, the converter achieves a remarkable peak efficiency of 98%, operating at a switching frequency of 750 kHz. This high frequency allows for a reduction in the size of passive components, including the inductor and input/output capacitors. A 1.5 µH molded inductor with low



DCR and only 3.5 mm height complies with the stringent profile restrictions of modern computers. The key to this high efficiency and power density lies in the use of two latest-generation 100 V rated, 4.2 mΩ, EPC2619 eGaN transistors [7], configured in a half bridge.

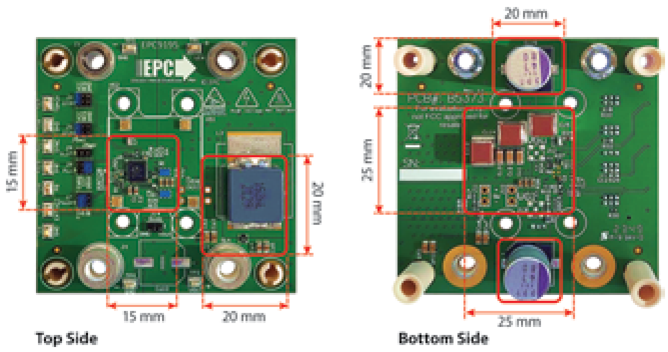


Figure 3: Shows the functional circuit area of EPC9195 Board

The GaN devices are paired with the LTC7891 IC from Analog Devices, which integrates both the buck controller and the half-bridge gate driver onto a single chip. The result is a very simple and compact solution with a minimal component count. For more details, refer to the functional block diagram of the EPC9195 design provided in Figure 4.

Power Transistor

In the EPC9195, two EPC2619 GaN transistors are configured in a half-bridge configuration. These 100 V rated transistors boast superior performance and power density to competing silicon FETs with similar voltage ratings. With a footprint of only 2.5 mm x 1.5 mm, they offer a maximum $R_{DS(on)}$ of 4.2 mΩ and the lowest commercially available $R_{DS(on)}$*C_{OSS} at this voltage. Low $R_{DS(on)}$ is crucial to minimize conduction losses while low C_{OSS} helps in reducing the transition times and minimizes switching losses. The combination of these factors leads to a significant improvement in overall efficiency and impressive power density.

Controller

The EPC9195 employs the LTC7891, a synchronous step-down peak current mode controller from Analog Devices. Operating at a fixed frequency of 750 kHz (configurable up to 3 MHz), the LTC7891 offers adjustable dead time between switching the high-side (Q_1) and low-side FETs (Q_2). Dead time refers to the brief period when both the high-side and low-side FETs are off during switching cycles. Users can adjust this parameter to 10 ns, 20 ns, or near zero. This feature is particularly beneficial for GaN FETs, which have inherently higher reverse conduction voltage compared to traditional MOSFETs. Minimizing dead time to near zero reduces energy losses that occur when the lower FET (Q_2) conducts reverse current, resulting in significantly improved efficiency while maintaining the advantages of GaN FETs.

The EPC9195 also offers adjustable inductor current limit to ensure the current delivered through USB 3.1 PD does not exceed 5 A or the maximum allowed power, ensuring compliance with USB specifications. Users can set the peak current threshold to 25 mV, 50 mV, or 75 mV to achieve the desired level of protection. For more information, please refer to [5]. Additionally, the controller offers three light-load power-saving modes: bursting mode, pulse-skipping mode, and forced continuous mode. These power saving modes help maintain high efficiency over the entire load range. Each mode provides a trade-off between efficiency and output voltage ripple. By selecting the appropriate saving mode, the user can achieve the balance performance for the specific requirement.

- Pulse-skipping mode: This mode balances efficiency with a lower level of output voltage ripple compared to bursting mode.
- Bursting mode: This mode prioritizes efficiency, but it comes with the highest output voltage ripple.
- Forced continuous mode: This mode delivers the lowest output voltage ripple, but at the expense of lowest efficiency.

Additionally, users can enable spread spectrum mode which is particularly beneficial for applications where electromagnetic interference (EMI) is a concern.

In summary, the EPC9195 with its cutting-edge design using EPC2619 GaN FETs enables a highly efficient and highest power density converter possible. This combination of efficiency and compactness makes the EPC9195 ideal for integration into portable devices. Furthermore, its compatibility with USB PD 3.1 standards makes it a perfect solution for powering next-generation electronic devices from USB PD 3.1.

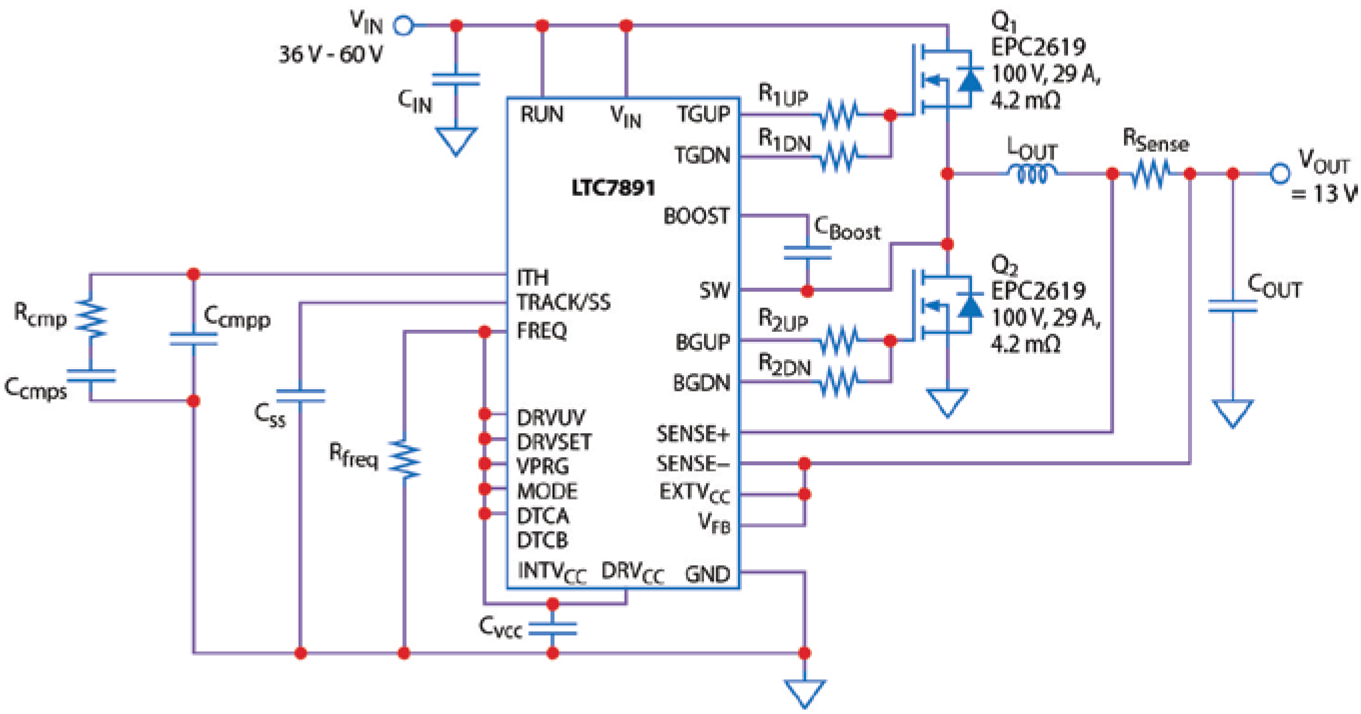


Figure 4: Diagram overview of the EPC9195 Evaluation Board

Design Validation Results

Electrical Performance

Figures 5 and 6 illustrate the measured efficiency and power losses of the EPC9195 under various supply voltages and output currents. The output current was swept for each input voltage until the input current reached 5.2 A, which corresponds to the maximum power allowed by the USB PD 3.1 specification. (refer to figure 1).

Figure 7 shows the voltage waveform at the switch node pin (drain of Q_2) referenced to ground. The waveform depicts the switch node voltage at an input voltage of 28 V and an output power of 140 W, highlighting the converter's impressive characteristic of switch node rise times below 2 ns, as well as the near- zero dead time feature.

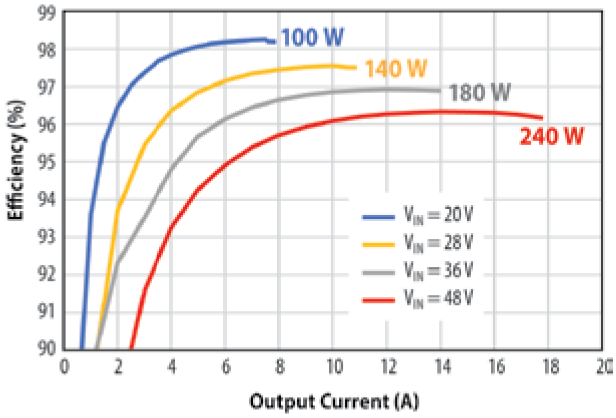


Figure 5: The efficiency graph at various input voltages and output currents

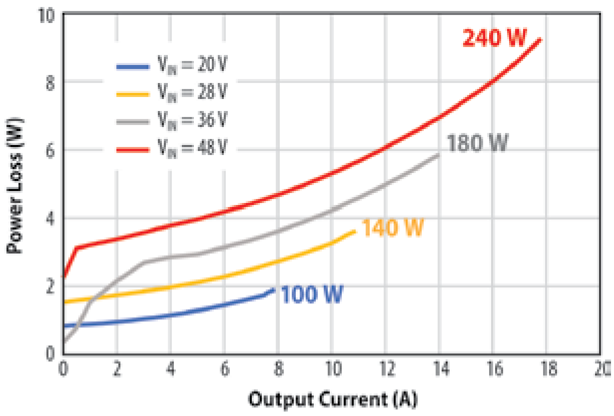


Figure 6: The power loss graph at various input voltages and output currents

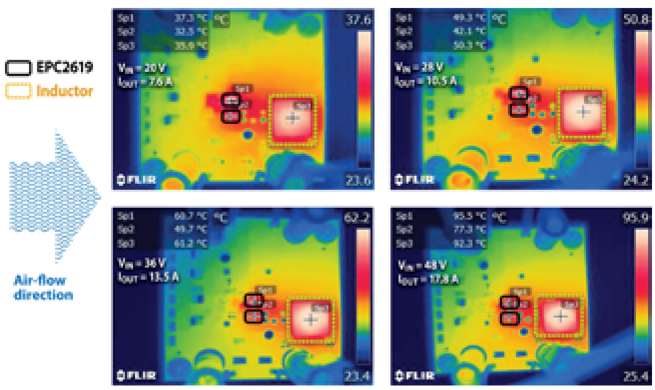


Figure 8: Steady state measured thermal image of the EPC9195 operating with different input voltages, 5 A input curent, 13 V output, 400 LFM airflow and no heatsink attached

Thermal Performance

Figure 8 displays the measured thermal performance of the EPC9195 operating with input voltages of 20 V, 28 V, 36 V, and 48 V. The output was set to 13 V and delivered with an input current of 5 A, without a heatsink installed and with 400 LFM airflow.

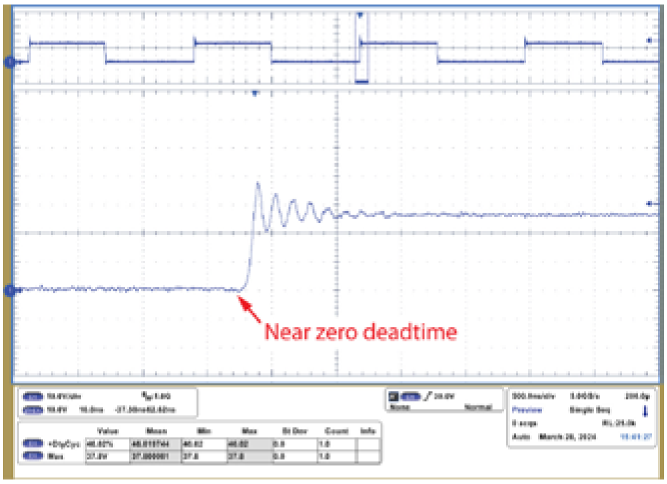


Figure 7: Zoom in view of switch node waveform the input voltage of 28 V and output power of 240 W

Summary

The article discusses the evolution of USB technology, particularly focusing on the USB Power Delivery (USB PD) 3.1 specification and the role of GaN technology in enhancing power delivery efficiency and density. It highlights the challenges posed by the increasing power demands of modern electronic devices and how GaN technology addresses these challenges. The article presents a case study of EPC9195, a reference design for a high-power density USB PD charger, showcasing the advantages of GaN transistors and an analog controller in achieving high efficiency and compactness. Experimental results demonstrate the performance and efficiency of the design, making it a suitable solution for next-generation electronic devices requiring USB PD 3.1 compatibility.

References

[1] Compaq Computer Corporation, Digital Equipment Corporation, IBM PC Company, Intel Corporation, Microsoft Corporation, NEC, Northern Telecom (1996). "Universal Serial Bus Specification, Revision 1.0," [online].
Available: https://fl.hw.cz/docs/usb/usb10doc.pdf

[2] USB Promoter Group (2021). "USB Power Delivery Specification Revision 3.1 announcement," [online]. Available https://www.usb.org/sites/default/files/2021-05/USB%20PG%20USB%20PD%203.1%20DevUpdate%20Announcement_FINAL.pdf

[3] Richtek (2022). "36V, 4-Switch Bidirectional Buck-Boost Controller with I2C Interface, RT6190 datasheet," [online]. Available:
https://www.richtek.com/assets/product_file/RT6190/DS6190-03.pdf

[4] A. Lidow, M. De Rooij, J. Strydom, D. Reusch, and J. Glaser, GaN Transistors for Efficient Power Conversion, 3rd ed. John Wiley & Sons, 2019. ISBN: 978-1119594147.

[5] Analog Devices. (2022). "100 V, Low IQ, Synchronous Step-Down Controller for GaN FETs, LTC7891 datasheet," [online].
Available: https://www.analog.com/media/en/technical-documentation/data-sheets/ltc7891.pdf

[6] EPC. (2024). "EPC9195: High Power Density, Synchronous Buck Converter," [online]. Available: https://epc-co.com/epc/products/evaluation-boards/epc9195

[7] EPC. (2023). "EPC2619 datasheet," [online].
Available: https://epc-co.com/epc/Portals/0/epc/documents/datasheets/epc2619_datasheet.pdf

Driving Innovation in Motion Control Applications

Vincotech's broad range of highly integrated power modules supports key motion control strategies, from general-purpose Variable Frequency Drives to application-specific designs.

By Michele Portico, Sr. Product Marketing Manager, Vincotech, Unterhaching

Motion control technology

Electric motors power the world around us. Look closely, and you'll find them everywhere, from domestic appliances such as washing machines and refrigerators to vehicles like cars, trains, and airplanes, providing countless modern conveniences. Invented in the 19th century by Werner von Siemens, Thomas Alva Edison, Nikola Tesla, and George Westinghouse – pioneering founders of their time who have since become household names – they remain at the forefront of innovation.

As a result, motion control has become a major part of modern industrial machine design. It involves carefully designing motors and incorporating control elements to ensure that motors move precisely how and when required by an application. Today, innovation in motion control technology focuses on improving performance and ease of use, as well as enabling new servo and motion control applications.

As a market leader in designing and manufacturing power electronics solutions that support motion control strategies for industrial applications, Vincotech caters to today's most important motion control use cases: industrial motor drives, embedded drives, heat pumps, HVAC systems, and elevator and servo drives. In this article, we dissect each of these use cases and show how Vincotech's extensive product portfolio helps system engineers mitigate risks associated with circuit design and speed up time to market.

Industrial motor drives

The operating speeds and torques of industrial motors vary considerably across applications. Variable frequency drives (VFD), placed between the power grid and the motor, offer an efficient way to control motors to meet application-specific requirements (Figure 1). These solutions have become increasingly popular in industrial applications because they deliver short payback periods thanks to energy and cost savings.

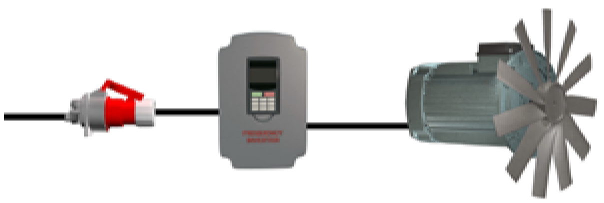


Figure 1: Variable frequency drive (VFD)

To highlight the benefits of variable frequency motor drives, consider an application requiring precise control of flow velocity or pressure. Traditionally, this type of application would use valves, dampers, or gearboxes for regulation while operating a motor driven pump at full throttle. However, operating fixed-frequency grid-driven motors at full power leads to a significant portion of energy being lost as heat.

Variable frequency drives avoid these losses by adapting the motor's speed and torque to the load or required work. Two parameters enable this adjustment: the voltage frequency, which sets the motor's speed, and the supported current, which determines its torque.

Figure 2 depicts the typical energy conversion process from a fixed AC voltage to a variable AC voltage:

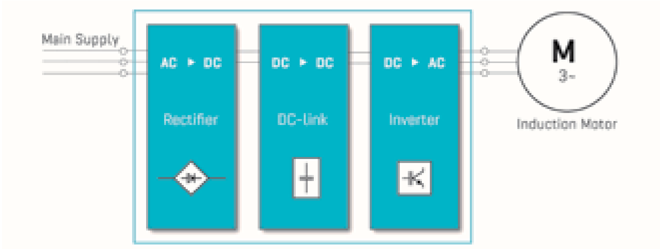


Figure 2: Energy conversion process using a variable frequency drive

The primary benefit of using a VFD is the ability to adjust a motor's speed to the needs of the entire application. Second is its ability to adjust the motor's torque, protecting the motor and the system it drives. Torque control can also translate to considerable power savings: A VFD-driven motor connected to a fan, for example, uses just one-eighth of its rated power because of the system's cube root speed-to-power relationship.

VFDs are not only relied on to accelerate motors, but also to stop or decelerate them in a controlled manner. Such controlled stopping or braking is vital for various applications such as elevators and conveyors. VFDs reverse their mode of operation without the need to reconfigure motor phase cables, simply by inverting the rotary field. By eliminating valves, dampers, and gear boxes, they enable the development of more compact systems with reduced maintenance and operation costs.

VFDs comprise three key components: a power rectifier used to rectify the AC input voltage; a brake chopper to protect the DC-link capacitor by dissipating energy generated by the motor during braking; and power semiconductor switches used to convert the rectified input voltage to the required variable voltage and frequency output.

Vincotech's offering for variable frequency drives include power integrated modules (PIM/CIB – converter, inverter, and brake), sixpacks (three-phase modules), half-bridges, and rectifier modules designed for standard industrial drive applications with power ranges from 1-60 kW.

Embedded drives

Embedded drives, which integrate the motor drive and the electric motor into a single unit, are gaining market share in industrial applications. Many suppliers offer embedded drive systems with varying degrees of customization. In addition to allowing customers to save space thanks to their compact, hermetic design, embedded drives can be tailored to specific applications to increase reliability and performance and, crucially, reduce cost.

Embedded drives comprise an input rectifier, a PFC boost stage, and a three-phase output inverter. Depending on the application, they can be implemented using a highly integrated intelligent power module (IPM) or a very flexible power integrated module (PIM). While IPMs include the logic components and gate drives required

by power switches, PIMs only provide the power components, requiring the gate drives to be mounted on the system's PCB (Figure 3).

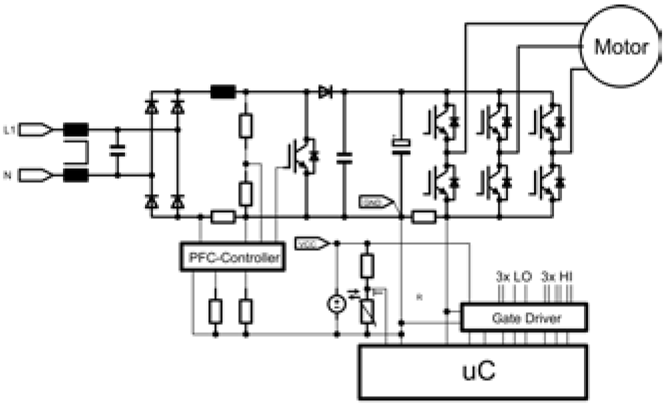


Figure 3: Power integrated module with PFC

Electronically controlled motors embedded in pumps, compressors, fans, and similar applications must fulfill two key requirements:

- Hermetic sealing: These motors require a hermetically sealed enclosure with a compact design and meticulous thermal management, as heat generated by gate drives, shunt resistors, and other resistive components can only be dissipated via a connected heat sink.
- Power correction factor (PFC): When these motors connect to the public power grid, the drives must incorporate power factor correction (PFC) to comply with regulatory standards.

To optimize the overall cost, size, and time to market of embedded drive solutions, system designers can integrate most functional blocks used by the motor drive, excluding the input filter, DC capacitor, and microcontroller, using an intelligent power module (IPM). This approach mitigates risks associated with circuit design, speeds up development, and cuts time to market.

While standard IPMs feature a simple three-phase inverter bridge with a compatible gate driver, highly integrated modules allow engineers to optimally combine power components and the gate drive circuit – critical elements in the inverter's design.

Vincotech's power module portfolio for embedded drives features 600V and 1200V intelligent power modules (IPMs) and power integrated modules with PFC circuits (PIM+PFC). With the highest level of integration of any power module available today, these modules offer the best solution for space-constrained mechanical environments.

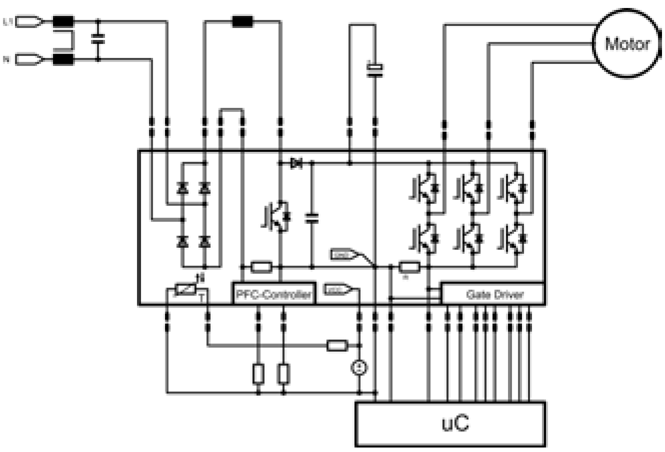


Figure 4: Intelligent power module (IPM)

Vincotech's *flow*IPM 1B and *flow*IPM 1C maximize their functional integration by integrating power semiconductors, integrated circuits, SMDs, and resistors into their substrate using thick-film technology (Figure 4). Their design integrates all active power components required for a three-phase inverter with active power factor correction (APFC). Components include capacitors to compensate inductive loops, shunts to sense current, a PFC controller and circuitry to divide the voltage, and DC capacitors. Two external resistors set the module's output voltage and PFC frequency.

Customers using the external microprocessor for the inverter to control the PFC can opt for a version of the module featuring only the PFC switch gate driver. In this case, they may have to include a negative supply and an amplifier for the PFC current signal. The microcontroller's ground connection is located on the positive side of the PFC shunt resistor (a direct connection to the microcontroller being impossible).

The optional Press-Fit interconnection further increases engineers' leeway in designing their target applications. Moreover, by leveraging the module's functional integration, drive manufacturers effectively offload R&D efforts to the module manufacturer, reducing development efforts while enjoying greater flexibility in defining functions and calibrating switching behavior. This flexibility is critical, as the filtering effort and switching losses of applications operating at 4 kHz PWM and 16 kHz need to be optimized differently.

PIM modules only include the power components – the input rectifier, PFC boost stage, and three-phase output inverter. The gate drive circuit and additional logic circuits must be included on the external PCB. However, they feature an integrated DC capacitor to reduce inductance and enable ultra-fast turn-off for the PFC switch.

Some PIM modules include a shunt resistor that senses current to control the PFC or the inverter. The open emitter structure in the low-side switches makes it possible to connect three external shunt resistors for vector control-based inverter designs. A temperature sensor provides the temperature of the heat sink adjacent to the module.

Heat pumps and HVAC

Increasing power density is a primary objective of heat pump and HVAC design. There are several ways to achieve this.

- Adopting more compact designs
- Increasing energy conversion efficiency
- Integrating cost-effective solutions

With its power-integrated module featuring an interleaved power factor correction circuit, Vincotech offers a unique and innovative topology for power modules with a high level of integration and improved energy conversion efficiency.

The interleaved configuration of the PFC circuit offers numerous benefits:

- Simplified PCB design
- Increased energy conversion efficiency
- Improved heat distribution
- Reduced component size on the PCB
- Simplified EMI filtering design
- Reduced output RMS current

Vincotech's new 600V *flow*PIM+PFC family includes four sub-families. These include a two-leg interleaved PFC circuit with and without an integrated input rectifier, and a three-leg interleaved PFC without an input rectifier. The offering further includes products based on the bridgeless totem pole interleaved PFC, also integrating the inverter stage (Figure 5). All variants feature a three-phase motor inverter and a temperature sensor.

The variants with a two-leg interleaved PFC also include shunt resistors in the motor inverter and the PFC circuit. By perfectly balancing the current in the PFC circuit, the common and leg shunts

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www.deantechnology.com | +1 (972) 248-7691 | info@deantechnology.com allow to increase the chipset's operational lifetime. Meanwhile, the integrated shunt resistors in the inverter leg vastly improve motor control. Furthermore, onboard capacitors dramatically reduce DC-link voltage overshooting.

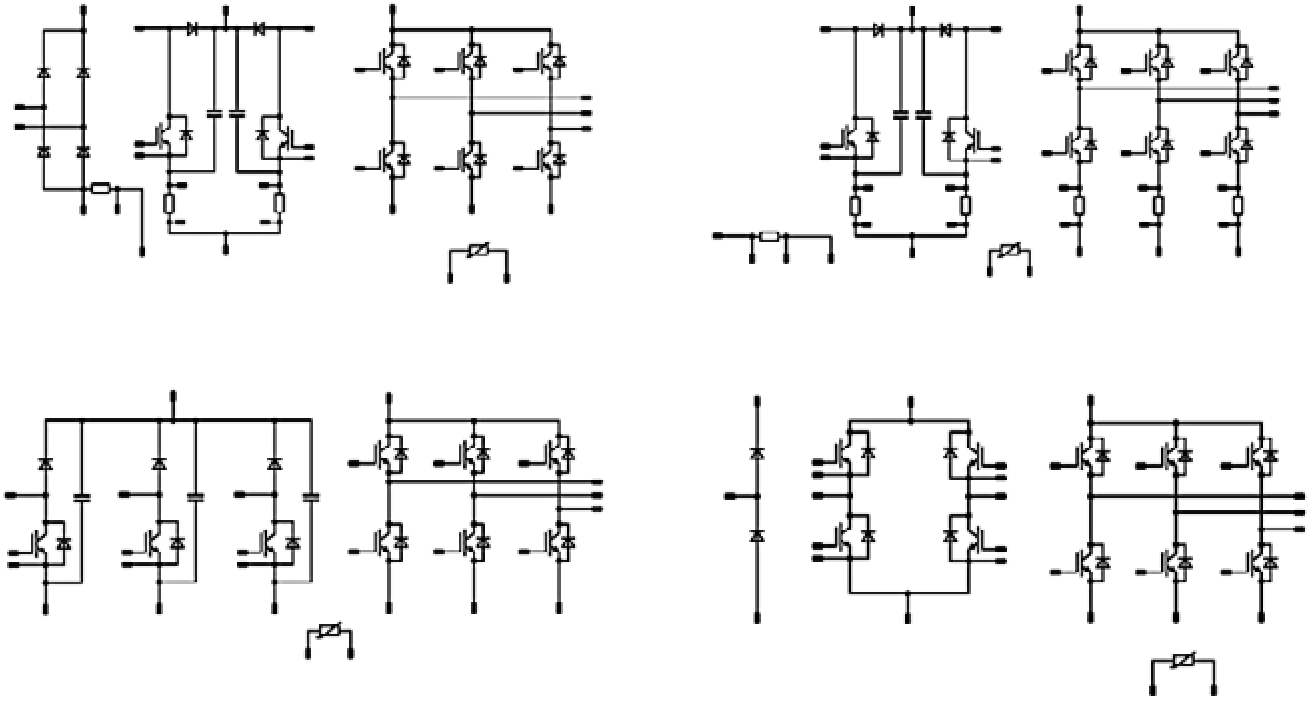

Figure 5: PIM with interleaved PFC

The 600V *flow*PIM+PFC modules optimally balance cost and performance. Their power pins, located at the modules' periphery, simplify and reduce the cost of PCB design. Separating the inverter and PFC parts further optimizes their thermal performance.

Elevator drives
In elevator and escalator systems, the main requirements for power modules are longevity and high switching frequency in the converter stage.

Vincotech's portfolio targeting these applications is built around the standard sixpack topology as well the sixpack topology enhanced with high-speed components. It also includes dedicated topologies that reduce the solution size and meet the application requirements by integrating two sixpacks for both the converter and motor stages.

These twin-pack modules, which typically include standard and high-speed components, use a tandem diode solution to reduce power losses and extend their longevity (Figure 6).

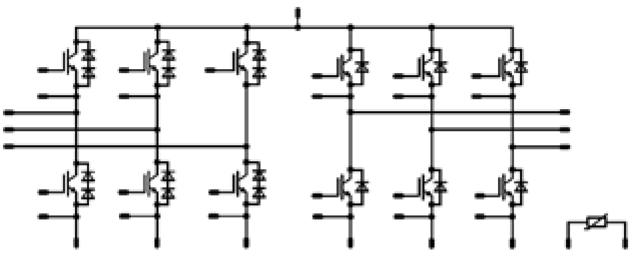

Figure 6: Twin-pack with tandem diode

Servo drives
Servo drive systems typically require switching frequencies between 10-16 kHz and output current overload of up to 130% of the nominal current value.

Vincotech's comprehensive product portfolio includes input rectifier modules and sixpack power modules for the motor stage. Equipped with high-speed components, the sixpacks mitigate overall power losses when operating at high switching frequencies. Tandem diodes further reduce power losses and extend the lifecycle of the components (Figure 7).

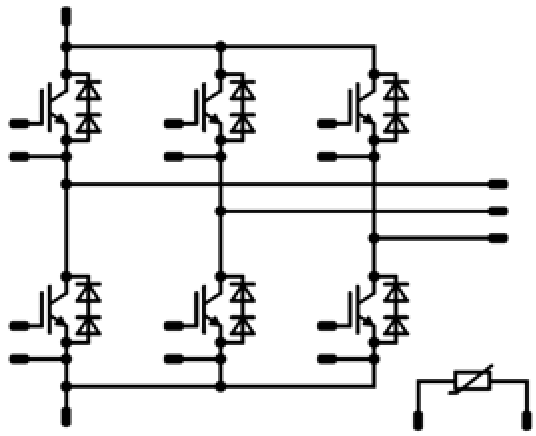

Figure 7: Sixpack with tandem diode

Vincotech: Your partner in motion control for industrial applications
Across the industry, electric motors are at work enabling modern life as we know it. These motors are controlled by power conversion devices that set the speed and torque of the electric motors to meet a wide range of specific application needs.

Vincotech's comprehensive product portfolio provides engineers the functional integration and power density they need to support motion control strategies for industrial applications. Combining a high degree of integration and innovation, they enable sleeker designs harnessing a proven blend of power components and gate drive circuits – crucial components of inverter design. This mitigates design risks and expedites development, ensuring a rapid path to market.

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How a Generation of Integrated Current Sensors Will Help Drive Global Electrification of Two- and Three-Wheel Vehicles

Electrification has become a major factor in the transport sector because it is one of the main contributors to greenhouse gas emissions. As countries strive towards the target of global CO_2 neutrality by 2035, cars, buses and taxis have been at the forefront of change.

By Charles Flatot-Le Bohec, Global Product Manager for e-mobility, LEM

Electric vehicles (EVs) have become commonplace, taxis glide silently up our high streets and '100% electric' vans and buses deliver parcels and people to their destinations.

However, with so much focus on EVs, it would be easy to overlook the light e-mobility sector, in particular the growing demand for the electrification of two- and three-wheel vehicles. While EVs have certainly garnered most of the attention and prominence in the transport sector, a much larger trend has been developing around the world.

The most common means of transport

The light mobility sector has experienced a significant acceleration in terms of electrification, in particular in South East Asian countries such as Malaysia and Indonesia, as well as India, China (and soon Africa) where two-wheel transportation is by far the most common means of transport. It has been estimated that there are around 70 million two-wheelers on the road and the numbers are growing at a rapid pace. It is widely expected that electrification of two-wheel vehicles will become more common in northern economies in the coming decade, with many companies in the USA and Europe already looking into launching products into this market.

In terms of growth, this sector is expanding faster than the four-wheeler market, not least because certification and design issues are much less complex. Similarly, battery management systems (BMSs) are easier to design for the sector because two-wheeler batteries are smaller with less power and voltage. All of this means that start-ups are able to address electric mobility issues much easier in the two-wheeler market than if they were having to design EV systems from scratch.

In 2021 around 6% of light mobility vehicles were electrified, the rest relying on the internal combustion engine (ICE). By 2030, it is estimated that e-scooters and motorbikes will between them represent 68% of the two-wheeler market. In more detail, sales of e-scooters are expected to reach 30 million within the next six years, e-motorbikes 23 million and e-bikes 40 million. At present, the electric two-wheeler market is based around 48V e-scooters but the growth is expected to come mainly from 100V-200V e-motorbikes followed by electric bikes with 36V systems. In India, powerful motorbikes represent the largest two-wheeler market and its growth is already inspiring a fresh wave of electric designs where lightweight, compact and durable components are essential requirements.

ICSs at the epicentre

LEM believes that Integrated current sensors (ICSs), with the current sensing function integrated into a single semiconductor unit, will be at the epicentre of the e-mobility market. This is because they combine precision, reliability and high-power density with a versatile and cost-effective means of addressing the voltage and current diversity that characterises this sector. In such a competitive and price sensitive environment, ICSs are able to offer an immediate solution for keeping costs down while also making maximum use of PCB space. In addition, they play a vital role in maximising safety, particularly in controlling BMSs which can enable batteries to have working lives of at least 10 years under normal operating conditions.

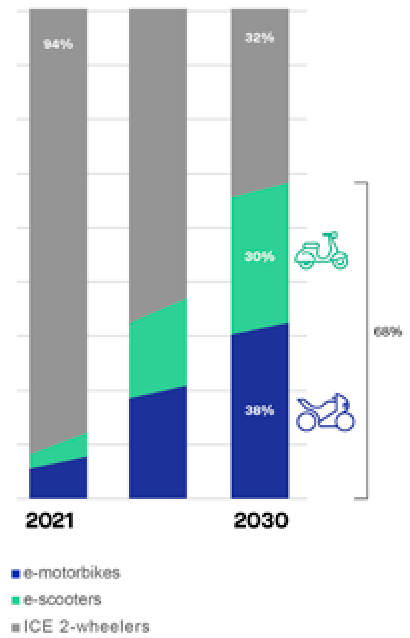

Figure 1: 2-wheeler market shares, ICE vs Electric

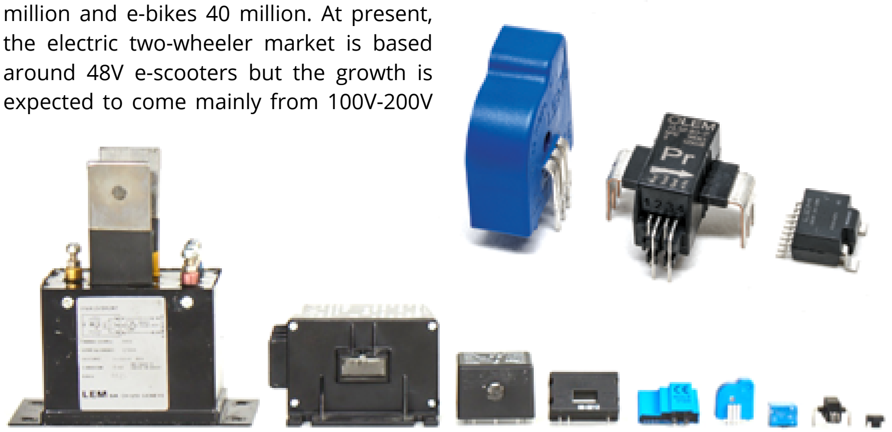

Figure 2: Miniaturizing the current sensing function

LEM has had its eye on this key strategic market for many years and is developing a portfolio that meets the requirements of the light mobility sector – especially electric two-wheelers with three-phase AC motors – with products that are just as advanced as those that are used in EVs. LEM's range of ICSs covers every part of the e-mobility sub-system which would typically include up to eight sensors per vehicle.

There are three main areas where ICSs represent the best fit for electric two-wheelers. The first is power conversion, where the charger turns AC power from the grid into DC for the vehicle's Lithium Ion (Li-Ion) battery.

In turn, there are typically three measurement points for current sensing in the charger that focus not just on power conversion but also on efficiency and control:

- one integrated current sensor carries out AC input measurement where the charger needs to check the current going into the system.
- a second ICS monitors the power transistors and switches that convert the signal from AC to DC. This current sensor synchronises the transistors to make sure the conversion is carried out in an efficient way.
- finally, a DC output current sensor measures the current that goes out of the system and compares it with the expected output current. Any difference will indicate a problem at the conversion stage which the microcontroller will need to adjust to ensure the desired output current is achieved.

Typical LEM ICSs used in this area would include GO sensors because the input sensor needs to be isolated due to the grid voltage. With the AC grid at around 200V-220V, at the input stage a GO SME ICS would be ideal for low current or a GO SMS for higher current. GO SME sensors are also suitable at the output stage because less isolation is required when working with 48V batteries.

Avoiding battery damage

The second key area for ICSs in electric two-wheelers is the BMS, with the aim of avoiding battery damage as well as potentially catastrophic failure events such as a fire or explosion. Operating as a protection and safety device, a single sensor in the BMS checks if there is a rush current or surge current in or out of the battery. If there is, the ICS will instruct the microcontroller to open the relay to prevent any more energy from going through the battery. Often, the ICS will work alongside a shunt that uses different technology to carry out the same measurements, with the microcontroller comparing the signals. This double redundancy means that if there is a failure of one sensor for any reason the other will continue to take measurements.

The third area where ICSs are ideal for electric two-wheelers is motor control, where the DC current from the battery is turned into three-phase AC current to operate the electric motor that runs the vehicle. Typically, four sensors would be operating here – one at the input stage and three at the output, all capable of being soldered automatically and directly on to the face of the PCB and take up minimum space. Again, the microcontroller is involved in checking that input and output levels are as expected. Safety is enhanced by all sensors at the input and output working in harmony to compare rates and ensure the operation is running as it should. With the microcontroller managing transistor gate drivers using the signal sent by the current sensor, this is a highly efficient control loop which provides accurate control over the motor. The result for the end user is smooth acceleration and maximum operational efficiency of the vehicle.

Typical LEM ICSs used in this area would be the HMSR SMS family, particularly because of a large primary conductor with very low electrical resistance and dedicated pads that make it capable of handling high currents if required. Featuring a micro magnetic core, HMSR sensors are immune to external fields, making them ideal for power electronic applications that have high levels of disturbance.

Conclusion

In short, integrated current sensors in electric two- and three-wheel vehicles are capable of offering superior performance in a smaller low-cost package that delivers impressive levels of power density in light mobility applications. The sensors combine high levels of isolation and accuracy with the ability to handle higher currents but in a more integrated package that can deal with issues directly on the PCB.

The global electrification of two- and three-wheel vehicles is set to take off and by delivering on precision, reliability, integration and power density, LEM's expanding portfolio of integrated current sensors will play a vital role in helping to drive growth in this sector.

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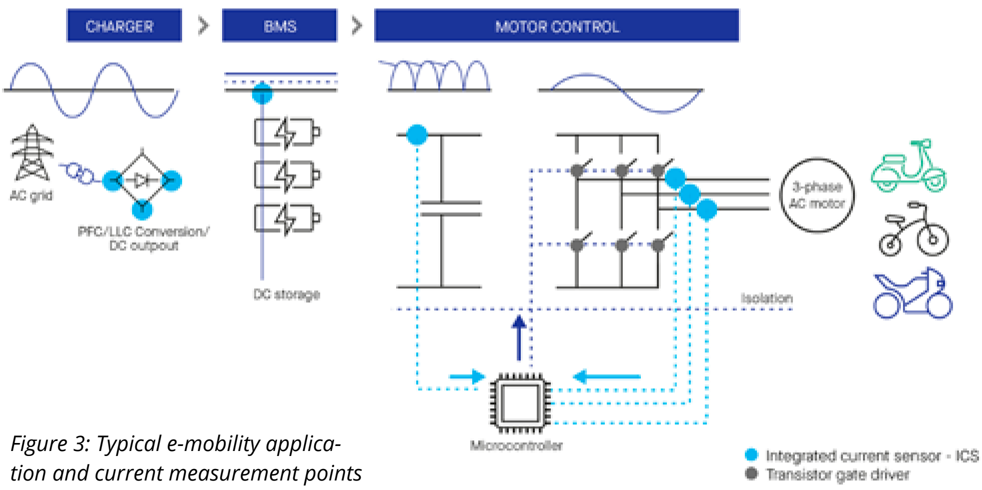


Figure 3: Typical e-mobility application and current measurement points

About the author

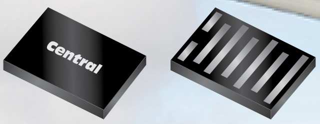
Charles Flatot-Le Bohec is LEM's Global Product Manager for current sensors in e-mobility markets.

He joined LEM in 2022 after 7 years in the automotive industry in marketing and purchasing positions at TOLV (EV retrofit), BorgWarner (Global Tier-1) and Nissan (Japanese OEM).

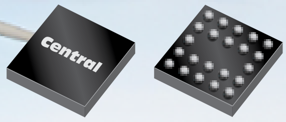
He holds a master's degree in management from EDHEC Business School and a Bachelor in Electronics and Embedded systems design from University of Grenoble Alpes.

He is building on his experience in strategy and operations for e-mobility electronics and semiconductors to develop LEM's footprint and solutions in the e-mobility segments, primarily focusing on Integrated Current Sensors.

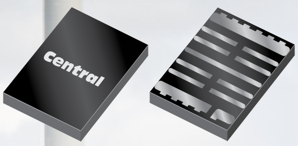
Explore our latest
GaN FET Solutions



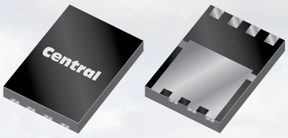
Top View Bottom View
CSP3.5X2 CASE



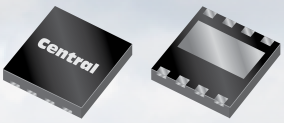
Top View Bottom View
CSP2X2 CASE



Top View Bottom View
CSP5X4 **CASE**



Top View Bottom View
DFN5X6A **CASE**



Top View Bottom View
DFN8X8 **CASE**

N-Channel GaN FET in DFN and Chip Scale

	Maximum Ratings (TA = 25˚C unless otherwise noted)					Electrical Characteristics: (TA = 25˚C unless otherwise noted)					
Central Item No.	VDS (V) MAX	VGS (V) MAX	ID (A) MAX	IDM (A) MAX	TJ, Tstg (˚C) MAX	rDS(ON) MAX	VGS(th) MAX	Qg TYP	Qgd TYP	Qgs TYP	Package
CCSPG1060N	100	-4.0 to +8.0	60	230	-40 to +150	3.2	2.5	1.9	1.7	1.1	CSP3.5X2
CDF56G6511N	650	-1.4 to +7.0	11.5	20.5	-55 to +150	190	2.5	2.8	1.1	0.25	DFN5X6A
CDF56G6517N	650	-1.4 to +7.0	17	32	-55 to +150	140	2.5	3.5	1.2	0.3	DFN5X6A
CDFG6511N*	650	-1.4 to +7.0	11.5	20.5	-55 to +150	190	2.5	2.8	1.1	0.25	DFN8X8
CDFG6517N*	650	-1.4 to +7.0	17	32	-55 to +150	140	2.5	3.5	1.2	0.3	DFN8X8
CCSPG0420N*	40	6.0	20	100	-40 to +150	4.0	2.4	15.8	8.6	1.9	CSP2X2
CCSPG0450N*	40	-4.0 to +6.0	50	200	-40 to +150	1.2	2.3	2.8	4.6	6.2	CSP5X4

*Available on demand

- Up-screening to equivalent MIL-PRF-19500 or Customer Specific testing available
- Standard and unique package options possible

N-Channel GaN FET Die

Bare Die - Available on Demand						
Central Die Item No.	Central Pkg. Device Item #	Die Size / MILS	Die Thickness	Topside Metalization	Backside Metalization	Chip Tray Pkg. Base
CPG007	CCSPG1060N	138.9 X 85	46.0	Ai-Cu 35000 Å	Si 21000 Å	88
CPG003	CDF56G6511N CDFG6511N*	132 X 55	45.2	Ai-Cu 35000 Å	Si 21000 Å	104
CPG004	CDF56G6517N CDFG6517N*	165 X 65	45.2	Ai-Cu 35000 Å	Si 21000 Å	60

*Available on demand

- Up-screening to equivalent MIL-PRF-38534 Class H, Class K or Customer Specific testing available
- Standard and custom metallization options possible

Modular dv/dt Pulse Generator Testbench for Insulation Endurance Assessment – Part 2

The development of power semiconductors, particularly WBG devices, has progressed significantly. This advancement has resulted in higher blocking voltages, reduced switching losses due to faster switching times, and the ability to create more compact systems by reducing passive components and optimizing space in power electronic systems.

By Dipl. Ing. Konrad Domes, M.Sc. Philipp Berkemeier, M.Sc. Felix Schönlebe (SAXOGY POWER ELECTRONICS GmbH)
Prof. Dr. Benjamin Sahan, Prof. Dr.-Ing. Christian Staubach, B. Eng. Kevin Kaczmarek, B. Eng. Stefan Reddig (Hannover University of Applied Sciences)

Failure of insulation systems due to power electronics

Despite these advantages, many developers and system engineers are not fully aware of the potential drawbacks of faster switching semiconductors. The development of fast power semiconductors bears new risks and challenges for established electrical systems, particularly the insulation system. It is important to consider these potential threats.

The first part of this article presented a current research topic on endurance tests of enamelled copper wires, to test for example the insulation system of motor windings. A few questions may have arisen:

- Have you ever wondered how much your insulation materials are stressed by up to 200 kV/us voltage slopes?
- Do you know how much displacement current will flow in your insulated hairpin wire under steep voltage pulses and how this affects the lifetime of the winding?
- Are you as a semiconductor manufacturer aware of the aging process of your packaging technology?

SAXOGY´s approach for a high voltage dv/dt pulse generator testbench

To develop the required test equipment, a circuit topology is needed that generates high voltage slopes and amplitudes while ensuring permanent non-destructive operation. SAXOGY® has developed an innovative circuit concept over the past two years that meets the new load requirements for a scalable high-voltage insulation test system for various applications. Figure 1 presents the hardware components of the pulse generator and Figure 2 shows a prototype of a complete testbench.

Traditional solutions are reaching their limits due to fast switching components. To avoid overloading our system and risking its destruction, it has been designed as a multi-level system and developed with a strict insulation approach. While not exceeding the standard usage level of the components, we attain voltage slopes that are often multiple times greater than usual.

Figure 1: SAXOGY's Adjustable Slope HV-Generator

Due to the high required dv/dt and excellent adjustability, it quickly became apparent that SiC-MOSFETs should be used. However, as there was no single device that meets the requirements regarding breakdown voltage, it was necessary to connect multiple standard devices in series. Direct series connection, is complex, which led to a cell-based cascaded H-bridge topology.

Simultaneously switching individual cells can significantly increase the output voltage slope, depending on the number of cells used. For example, if a single cell switches with a slope of 20 kV/µs, the slope can triple to 60 kV/µs if three cells are involved in generating the output voltage.

Traditionally, the cascaded H-bridge topology requires individual transformers in each cell for the power supply. However, these transformers exhibit high coupling capacitances, resulting in increased displacement currents. This can pose a risk of damaging the insulation and ultimately lead to transformer failure over time. Hence, SAXOGY® has invented an innovative topology that operates with only a single power supply and at the same time can be extended for higher voltage levels.

The inverter topology is extended with an additional charging path. Similar to the principle of a "bucket chain", energy is transferred from the power supply unit into the first cell and, in the next step, energy is passed on from the first to the second cell. This process continues until the top cell in the system has also been recharged and the charging sequence starts all over again. To ensure that the recharging of two cells

Figure 2: Example of an early prototype testbench

works, one cell operates as a «charging cell» and cannot provide any voltage at the output for the duration of charging. All cell voltages in the system can be maintained by matching the charging frequency to the application.

Figure 3 displays the topology of the SAXOGY® dv/dt pulse generator, using a three-stage system with a supply voltage of 750 volts. The switching configuration for positive output voltage and charging of cell two is shown. Cell one functions as a charging cell and does not output any voltage, but is connected in parallel to cell 2 via the switch T5. The current flow (red arrow) between the DC link capacitances is limited by a current rise-limiting inductance and a diode in the charging path, which also prevents oscillations of the resonant circuit. Alternatively, a current-limiting resistor can be used instead of the inductance, but this results in additional losses and reduces the recharging efficiency.

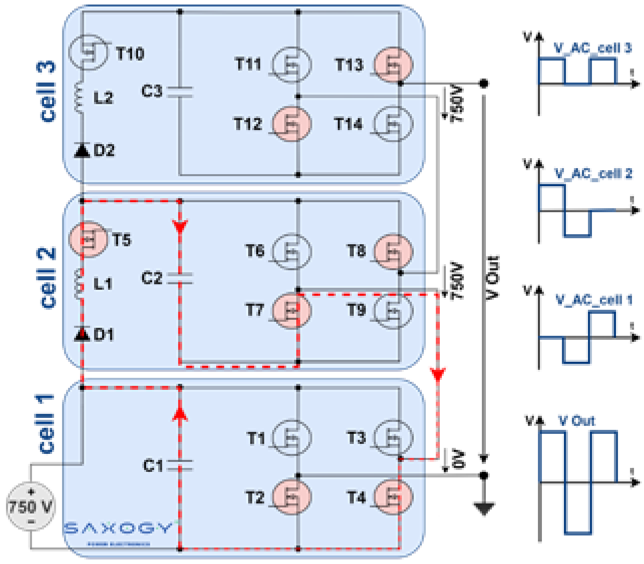


Figure 3: SAXOGY's advanced transformerless multi-level topology

Setting the correct stress level for your insulation

Thanks to the modularity of the topology, the output voltage can be adjusted as required by the application. To cover current and future insulation tests, the generator can provide bipolar voltages from 0,4 kVpp to 12 kVpp.

The rectangular voltage waveform can be set in a wide range from 2 kHz to 20 kHz to apply additional stress to the test specimen and shorten the test duration.

As demonstrated by the research findings in the first part of this article, doubling the rise times results in roughly halving the lifetime of an insulation system. To vary the rise time, we used a high level of expertise to dynamically adjust the voltage dv/dt slope in real-time using a self-developed gate driver. This ensures an almost linear voltage slope, resulting in a constant displacement current over the entire voltage rise.

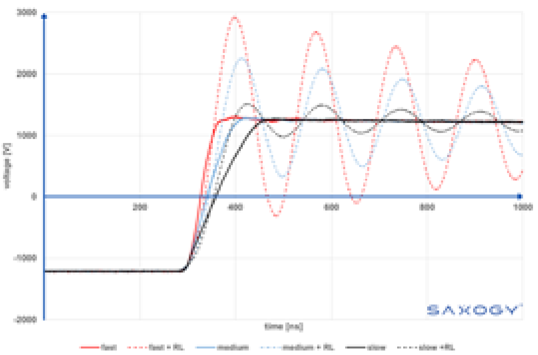


Figure 4: Adjustable rise times and optional overshoot via passive network

The gate driver is designed to enable a switching behavior that keeps the generator voltage overshoot below 2 %. Figure 4 demonstrates the adjustability of the voltage gradient at 1200 V and the almost linear voltage slope by displaying three out of sixteen voltage gradient settings. To expand the range of applications for the high voltage dv/dt generator, an additional overshoot can be generated by using external passive RL-networks (dashed lines). This enables testing of motor windings in worst-case scenarios.

The generator is addressed via Modbus TCP and is therefore very easy to operate.

Tailored solutions for your needs

The pulse generators are customized according to your specific requirements to create an optimal test bench. They are available in different versions, all housed in a 19” rack-mountable enclosure. The most suitable variant for you depends on your needs and the associated integration costs.

Figure 5: Available options for the HV dv/dt Pulse generator

Further, we offer testing services according to your specifications in-house in our laboratory.

Meet us at PCIM 2024 - Hall 7 Stand 135

As every year, we will be exhibiting at PCIM 2024 in June. Perform your own live insulation tests and observe the generator in operation during a cup of coffee. Alternatively, we would be happy to talk to you sooner.

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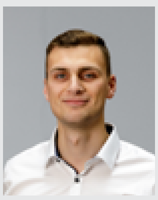
Konrad Domes: "SAXOGY® has been developing safety test benches and test generators for power electronic systems and components for 20 years."



Philipp Berkemeier: "Progress in developing fast-switching devices is necessary and desirable - but it also presents new challenges in terms of stressing insulation systems. These challenges should be considered in the development of power electronic systems."

Benjamin Sahan: Our jointly developed modular dv/dt pulse generator sets new standards in motor insulation testing. The innovative and highly reliable concept is the perfect solution for demanding testing applications.""

Empowering Defense Applications with MIL-COTS Front-end Filters

Military applications are the most demanding and require special filtering and protection circuits to ensure safe operation under extreme conditions. The following article describes how these challenges can be solved and shows some typical power solutions.

By Goday Lai, Senior Technical Support Engineer, P-Duke

Today almost all power converters use topologies switching at frequencies of several hundred kHz and are therefore generating a certain amount of conducted and radiated high frequency noise. For very low power levels of a few Watts a simple PI filter solution integrated into a power converter may be sufficient. Designing an EMI filter for a system drawing several tens or hundreds of Watts can become a real challenge and requires a sound knowledge in HF design and proper layout. Each converter topology generates a different spectrum of high frequency noise, varying also by the amount of power drawn by the application, and the filter must be designed for all operation conditions. Before a filter solution finally meets the specifications, it can take several trials and tests in an expensive approval lab, specialized on MIL standards. This time-consuming process adds a significant amount of money to the overall design cost of a new project, which must be amortized over the usually lower quantities in MIL applications.

Space and weight in military equipment are often limited as systems are packed with complex electronics and sensors. A highly sensitive measurement or communication device may work near to a power converter and no interference is allowed between different systems. Therefore, EMI specifications for MIL applications are more stringent than in other markets making the filter design even more complex.

Another challenge are the extreme environmental conditions including high mechanical stress caused by shock and vibration. Magnetics and capacitors needed for EMI filters are bulky components and special means are needed to avoid any damage of components or solder connections by high shock and vibration.

Saving Engineering Ressources

Why spending a lot of money and weeks of valuable engineering resources when off the shelf filter solutions are available, meeting all these requirements and tailored to a wide range of DC/DC converters? The MCF-028 front-end filter family from P-Duke was designed to cover power ranges from 45 W up to 250 W in typical 28 V defense applications. Their filter behavior is compliant to hundreds of DC/DC converters and by following the recommended PCB layouts, it is very easy to design a system which passes the EMI tests the first time without the need for further redesigns.

Touch screen (120W)

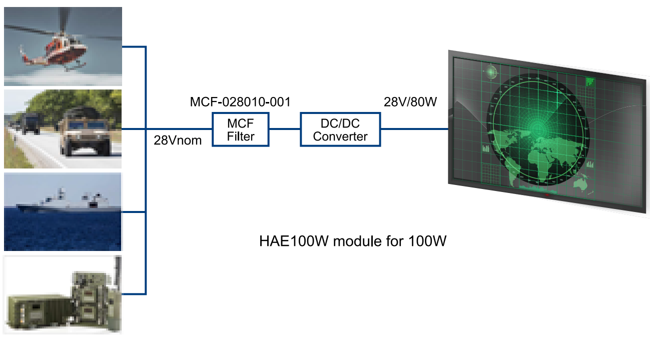


Figure 1: regulated 28 V/80 W supply for a MIL touch screen.

An example is the 80 W power solution for a touch screen, which requires a regulated 28 V supply voltage to be generated from the unregulated voltage of MIL vehicles. It uses the MCF-028010-001 filter rated for up to 10 A and a 100 W converter from the HAE100 family (figure 1).

In an application note P-Dukes provides a list of all necessary external components and a recommended PCB layout. When following this guide a design passing all tests can be made even without a deep knowledge of HF and EMI filter technology. Figure 2 shows the EMI plot of this solution.

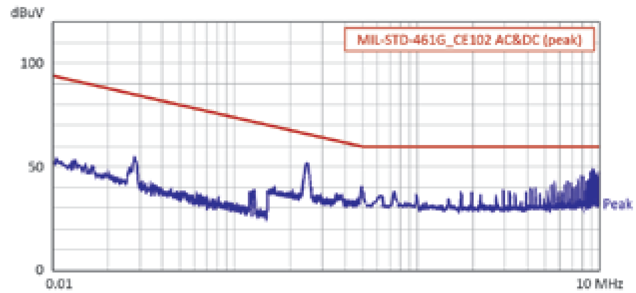


Figure 2: MIL STD 461G CE102 Conducted Emission MCF 028010 001 combined with HAE100 24S28W at Vin (nom) and full load

Another challenge in MIL applications is the wide range of the input voltages including heavy transients and spikes. Following table shows the summary of different standards:

Standard	Un (VDC)	Permanent Operating Input Range (VDC)	Transient	Spike
MIL-STD-1275E	28	23 – 33	40V / 500ms 100V / 50ms	±250V / 70µs
MIL-STD-704F	28	22 – 29	50V / 50ms	N/A
RTCA DO-160G Cat. A/Z	28	20.5 – 32.2	80V / 100ms	±600V / 10µs

According to MIL-STD-1275 the 28 V nominal voltage can drop to 16 V during cranking of an engine and even 12 V for one second during initial engagement of a system. On the other side the system must also be able to handle these high energy transients of up to 100 V/50 ms or 8 0V/100 ms and spikes up to ±250 V/70 µs or ±600 V/10 µs.

Technically it would be possible to design a DC/DC converter working over this wide input range of 12 – 100 V but the solution would be bigger and less efficient than a significantly smaller filter and converter combination tailored to these specific needs.

The converter must be able to work at the low input voltages and all converters offered by P-Duke for these applications can handle input voltages down to 9 V and are designed to work with input voltages up to 36 V continuous and 50 V for one second.

An active circuit already integrated in P-Duke's MCF-028 front ends clamps the 100 V/50 ms and 80V/100ms transients to only 40 or 46 V, no problem for the P-Duke converters with their input transient capability of 50 V for one second. Figure 3 shows the input transients applied to a MCF-028010 and the output voltage clamped at 46 V.

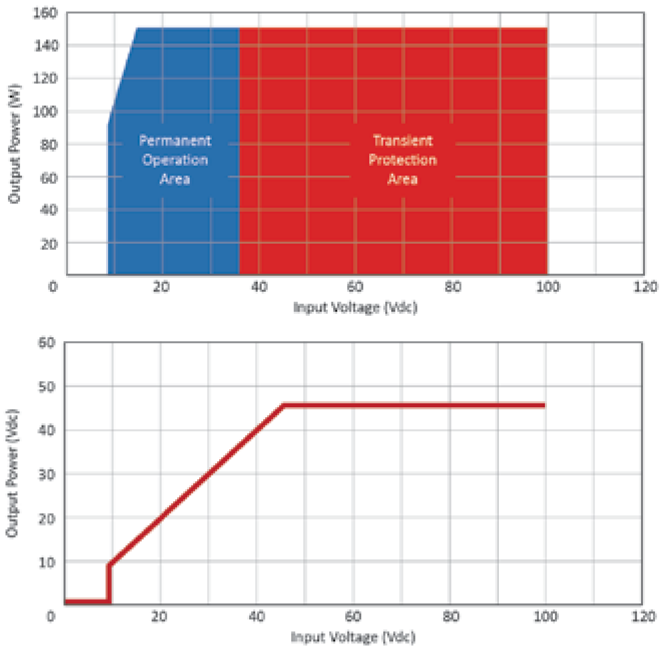


Figure 3: transient voltages at the input of a MCF-0280100 module (top) and clamped output voltage (down)

The very short ±250 V/70 μs or ±600 V/10 μs spikes are suppressed by additional components inside the MCF028 and in combination with a P-Duke converter all these transient specs are met. The extreme flexibility of P-Duke's power component offering is shown

Onboard computer (120W) and touch screen (120W)

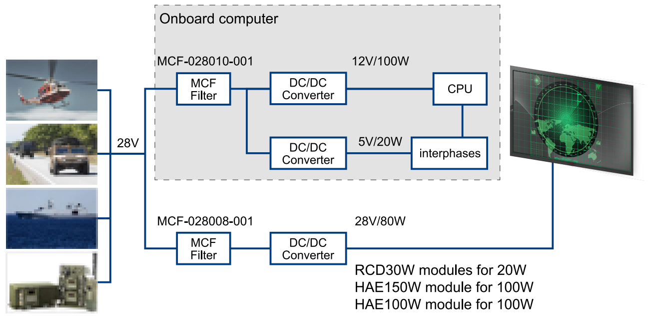


Figure 4: power solution for an onboard computer system with touch screen

Vehicle mounted Satcom system (230W)

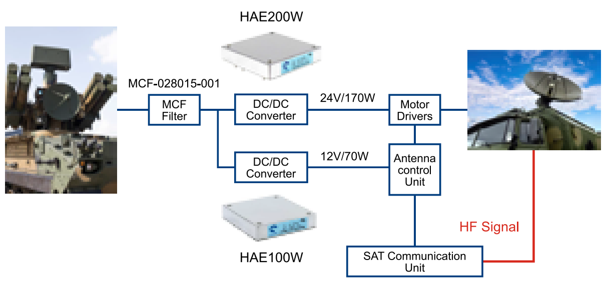


Figure 5: Power solution for a vehicle mounted mobile SAT com system

when locking at some more application examples. Figure 4 shows the block diagram of a complete onboard computer system including the previously mentioned touch screen and a typical computer using ruggedized CPU, memory, and interface components.

When more power is needed, the MCF-028015 can handle currents up to 15 A and support downstream converters for loads up to 250 W. A good example is a vehicle mounted SAT com system (figure 5). When the vehicle drives in rough terrain, powerful motors are needed to continuously reposition the SAT dish.

MIL equipment not only has to work under very harsh environmental conditions, it also must be fault tolerant to many operating or installation errors. A reverse polarity connection to a battery can damage the complete system. Switching on many loads at the same time can generate high inrush currents and trip system relevant fuses. P-Duke considered these handling errors when designing the MCF Frontends and has included an active inrush current limiter and reverse polarity protection as well as under- and overvoltage, short current and over temperature protection. A remote on/off function allows switching the outputs of each module on and off, enabling a controlled ramp up or ramp down of converters in a larger array.

Figure 6 describes a complex mobile network link solution for the communication between UAVs, ground vehicles, ground and portable stations and a central HUB. Different Combinations of P-Duke's MCF028 front ends and DC/DC converter families made designs for the various power needs quick and easy. Even when switching on various systems connected to the same source in a ground node group, the inrush current limiting guarantees that no fuse will trip. The EMI performance of the filters makes sure that noise from a converter will not be coupled into the communication network disturbing mission critical communication.

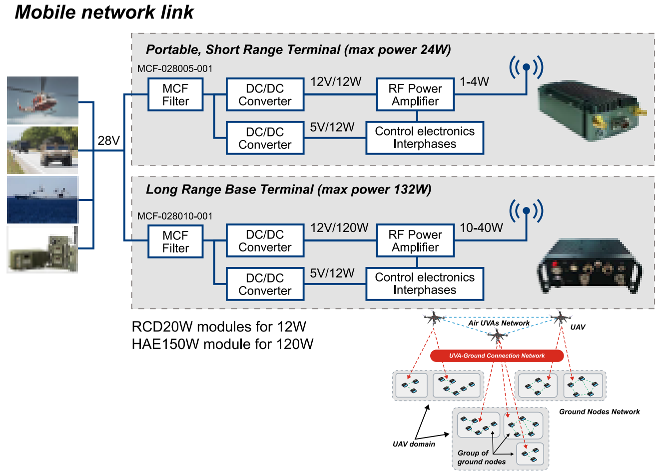


Figure 6: P-Duke's extensive range of filters and DC/DC converters enabled quick and easy designs for various power needs.

P-Duke's product range for the MIL market does include modules with single and dual output voltages and voltages going beyond the standard offering of other suppliers. For the redesign of a surveillance system a customer wanted to use PTZ cameras with high power LEDs for long distance night sight, each requiring almost 50 W of power. Installation in the field must be quick and easy with one cable carrying power and signal. A power over Ethernet solution was needed but the typical solutions available at that time in the MIL market did not allow bringing 50 W to each camera over the thin cable. By using the PoE++ (IEEE 802.3bt, 50 – 57V supply voltage) specification and a standard P-Duke 100 W module with its 48 V nominal output trimmed up by 10% to 52.8 V, the challenge was solved.

The surveillance control system needed a regulated 28 V/40 W supply. Easy to achieve with a RED60 module as the 24 V nominal output can be trimmed up by +20%, quite unusual for a standard DC/DC converter module. One 250 W MCF028 can power up to 4 cameras and there is still enough power for the surveillance system (figure 7).

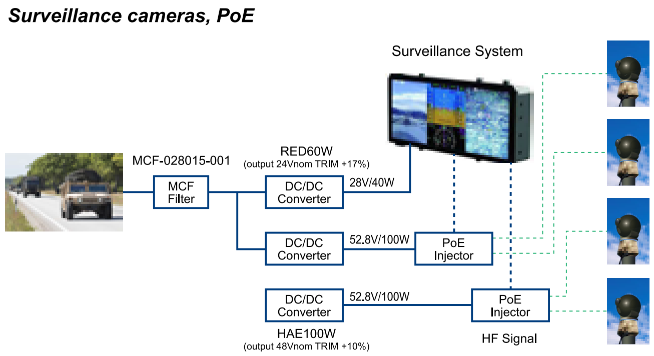


Figure 7: PoE camera solution using the MCF frontend filter and standard converters with the outputs trimmed up to achieve the 52.8 V and 28 V voltage requirements.

The harsh environmental conditions of MIL applications can become a major challenge when designing power solutions. The systems must work reliably over wide temperature ranges and withstand high shock and vibration stress.

Engineers designing their own power converters and filters face the challenge that standard magnetics and capacitors are large and bulky and therefore sensitive to shock and vibration. P-Duke modules are using special flat and lightweight components and together with silicone potting mechanical stress is reduced to a minimum. Therefore, all modules meet MIL-STD-810F for shock and vibration.

	Portable system		Base station	
Frontend filter	MCF-028005-001	19.7 g	MCF-028010-001	64.0 g
12 V supply	RCD20-24S12W	16,0 g	HAE150	105,0 g
5 V supply	RCD20-24S05W	16,0 g	RCD20-24S05W	16,0 g
	Total weight	51,7 g	Total weight	185,0 g

Another big advantage of using a modular approach and these small components is a significant size and weight reduction compared to any discrete design. Complete weight of all modules used in the example of figure 5 is only 52 g for the portable and 185 g for the powerful base station version.

To protect military electronics against water, humidity, and aggressive atmospheres it is quite often mounted into a sealed housing. Conduction cooling can be realized by attaching the baseplate or top cover of the modules to the hermetically sealed chassis of the system (figure 8). This construction offers ideal heat management options, can withstand very high shock vibration stress, and does not need unreliable fans.

Figure 8: All P-duke modules come in a robust silicone potted housing and cooling can be done either through the baseplate (>100 W) or top of the module (10 – 60 W).

This robust construction, designs with lowest losses and therefore low heat dissipation, the selection of highly reliable components in combination with a production process meeting high quality standards and 16 hours burn-in of every product make sure that the components will work reliably in these demanding MIL applications. This table shows the MTBF values (MIL-HDBK-217F, full load) for the MCF028 filter series:

MCF-028005	2.718 x 10^6 hrs
MCF-028008	1.146 x 10^6 hrs
MCF-028010	1.307 x 10^6 hrs
MCF-028015	6.095 x 10^5 hrs

The DC/DC converters shown in the examples achieve similar MTBF values and P-Duke has a proven record of meeting the extremely demanding reliability requirements in defense and railway applications working under extreme environmental conditions. When using this modular approach, a design can be done in a few days or weeks and does not need months of valuable engineering resources.

www.p-duke.com

Gate Drivers with Dynamic Gate Strength Improve EV Performance

NXP's GD3162's dynamic gate drive function delivers optimal switching performance for advanced power switch devices (e.g. SiC, GaN) over increasingly wide operating ranges. Dynamic gate strength on the GD3162 device boosts inverter efficiency, delivers a strong functional safety solution, and improves upon typical hardware design criteria to protect the power device.

By Travis Alexander, Systems & Applications Engineer, NXP Semiconductors

The definitive features of an electric vehicle (EV) may be its battery and its electric traction motor, but these two necessitate the existence of a third element that is just as fundamental: traction inverters. A traction inverter is what makes it possible for an EV battery to work with an electric motor, converting DC power from the battery into AC power to drive the motor.

The EV market is now firmly established, but EV technology is far from fully mature. There are still improvements in EV performance, reliability and safety that are possible, and the automotive industry remains busy pursuing them. Significant attention has been focused on battery and motor technology, but a recent innovation in traction inverters is also consequential.

Gate drivers for traction inverters have recently been introduced that for the first time can toggle between multiple, preset current values in response to EV operating conditions; in other words, the gate drivers offer dynamic gate strength. One of the first examples is NXP's GD3162.

The ability to change the gate strength makes it possible for the inverter control algorithm to optimize the switching rate of the inverter's power device for the present condition on the motor. Examples include when the environmental temperature is very cold (which can affect the switching rate of the power device), or during regenerative braking (which can increase the bus voltage and cause device stress from overshoot), with vehicles that offer that feature.

The key benefit is that the overall efficiency of the EV is increased, but NXP's innovation also delivers a strong functional safety solution, while improving upon typical hardware design criteria to protect power devices. It is up to the auto manufacturer to choose how to take advantage of the efficiency improvements but, for example, the OEM can use the improvement to increase the vehicle's range by a modest but measurable amount.

Gate drivers

An EV's traction inverter must deliver high power levels that vary from 80 kilowatts to over 200 kW, withstand high temperatures, and be lightweight.

Gate drivers in traction inverters drive the inverter's power devices, traditionally silicon IGBTs but increasingly silicon carbide (SiC) MOSFETs. Power devices are the switches that convert DC power from the battery into AC power for the motor.

An EV's traction inverter typically incorporates six discrete gate driver ICs and six power devices, two of each for each phase in a three-phase AC motor (see Figure 1). The gate drivers – including the gate strength commands – are typically managed by the traction inverter's microcontroller.

Resistors are included to reliably limit peak current to charge or discharge the gate(s). Traditionally, the specific value has been fixed to protect against worst-case overvoltage, leaving potential energy savings on the table at more nominal conditions.

Dynamic gate strength

However, the ability to change the speed at which the gate turns on or off has many potentially advantageous effects on the power device itself as well as on the motor.

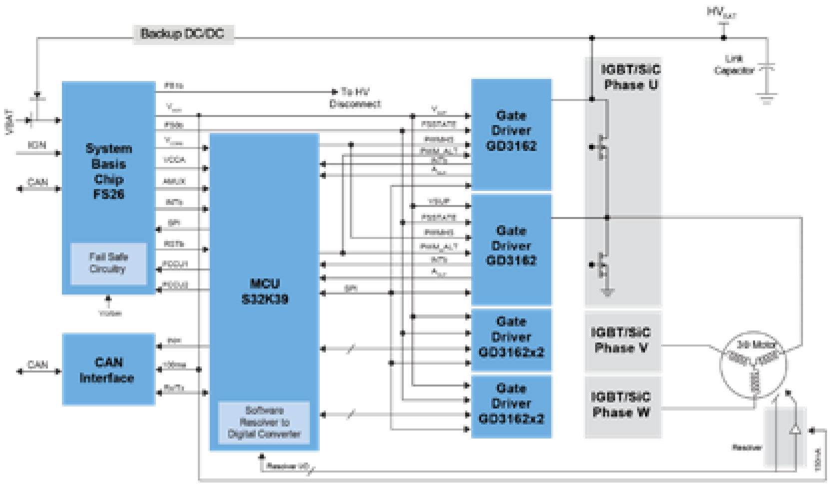


Figure 1: A sample schematic of a traction inverter for an EV. Six separate gate driver ICs are commonly used, two for each phase of a typical three-phase AC motor. The gate driver directly drives the power device — an IGBT or silicon carbide (SiC) MOSFET, which switches DC power from the battery to AC power for the motor. Gate drivers typically set the switching rate at a single specific value. A gate driver with dynamic gate strength, however, can vary the switching rate in response to motor conditions.

Power switches are well-characterized, but vehicles encounter any number of conditions that affect the electrical performance of the power switches. A partial list includes changes in motor current, the battery/bus voltage, and power device temperature. Tuning the gate drive current is the means of modulating the switching event (energy) for the specific condition, which is invaluable for maximizing efficiency in all conditions (Figure 2).

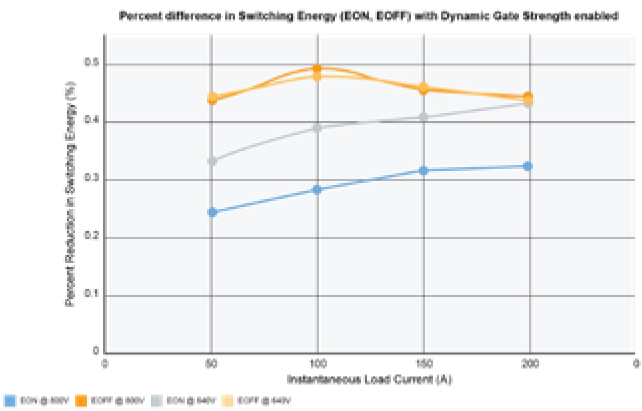


Figure 2: A comparison of EON/EOFF at range of currents.

The performance of the inverter (and therefore of the vehicle as a whole) could be more efficient if the switching behavior can be selected based on driving conditions – if dynamic gate strength were an option.

NXP affords this option by integrating additional pins in its gate drivers. The NXP GD3162 gate driver has two pins for turn-on and two for turn-off paths, which may be independently articulated. It offers the choice between outputs of up to roughly 10 amps, or up to roughly 20 A, along with the third option of using the two together to provide up to roughly 30 A.

Why “roughly”? As a practical matter, the OEM or system designer is likely to want to include a power-limiting resistor to limit the current so that the values are something less than 10 A, 20 A, or 30 A, based on the OEM’s preferences and other system constraints.

The gate strength can be controlled by digital input pins or SPI command (figure 3). Either way, customers can choose to drive their power devices as hard as they want. With such a wide range of possible currents to drive the gate with, the GD3162 is even capable of driving multiple devices or die in parallel.

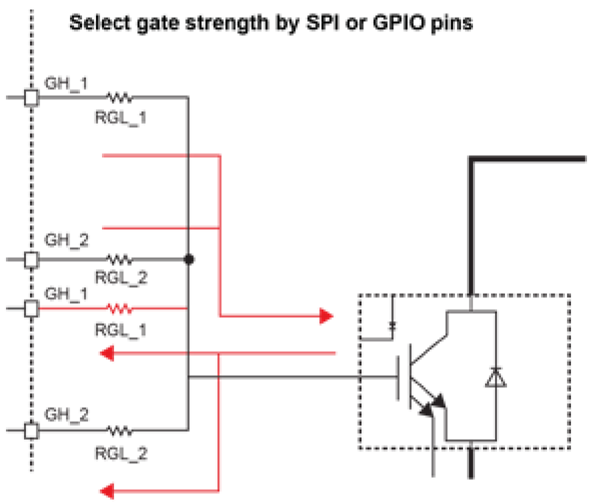


Figure 3: This application diagram of the GD3162 gate driver includes two separate turn-on and turn-off resistors. Gate strength can be selected by SPI command or via GPIO pins.

The desired gate strength can be commanded and executed in real-time as the motor is spinning with the GD3162 device.

Efficiency

Power devices can be damaged by excessive voltage stress. Also, even though automotive electronics are rated to operate across wide temperature ranges, whenever it is possible to limit the thermal load on automotive ICs, including increasingly advanced gate drivers, it remains advisable to do so.

The design of the gate drive resistor typically starts by examining the worst-case conditions (e.g., max load, max voltage). The goal is to have sufficient resistance to provide protection when those conditions occur.

That does indeed minimize potential damage, but worst-case conditions are inherently atypical. Adding a gate driver that offers dynamic gate strength, such as the NXP GD3162 gate driver, creates the option to operate at gate strength settings that emphasize more typical (lighter) conditions.

The system continuously evaluates multiple system factors (current, voltage, temperature, etc.), and always controls the gate strength, operating at one setting the OEM designates as optimal for typical conditions, automatically changing to settings more suitable to atypical conditions when they occur, and then dynamically reverting when conditions return to typical. The GD3162 gate driver provides the system integrator more control as to how best to protect the power device. The associated boost in efficiency in modes more suited to typical operation can be significant.

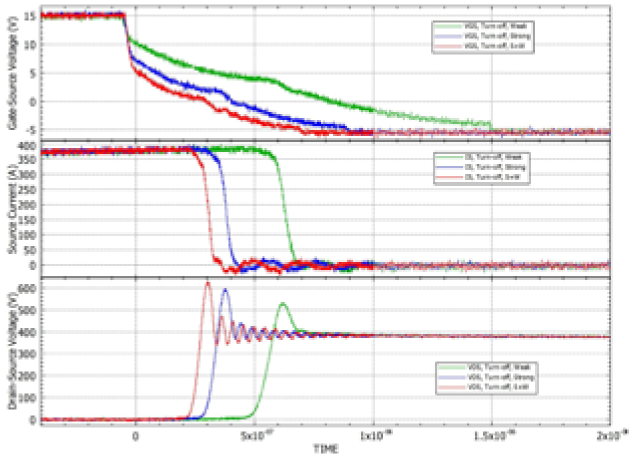


Figure 4: A comparison of switching events at high gate strength vs. low gate strength. GD3162 gate driver has the ability to affect the gate strength from the high-voltage side, via the ISEN/COMP pin.

System designers should consequently be able to employ a smaller cooling system, which would mean a size and weight reduction for the inverter as a whole. Reducing overall vehicle size and weight of course can ultimately have a positive effect on range.

Safety and reliability

Traction inverters are a safety-critical application, and typically carry ASIL D requirements. Gate driver ICs must contribute to the functional safety goals of the traction inverter. The GD3162 gate driver is rated ASIL C/D, and meets the requirements of automotive applications, being fully AEC-Q100 grade 1 qualified.

The GD3162 device uses two pins for turn-on and off, protecting against single-point failures in the gate drive resistor. The device also reports the commanded and received gate strength, protecting against latent failures or a real-time breakdown in the gate strength command.

NXP traction inverter solutions

The GD3162 is an advanced, galvanically-isolated, single-channel gate driver designed to drive the latest SiC and IGBT modules for traction inverters in battery EVs, hybrid EVs, and others (xEV).

The GD3162 offers an adjustable dynamic gate strength drive feature with powerful efficiency and safety benefits. In addition, advanced programmable protection features are autonomously managed as faults and the status of the power device and gate driver are reported via the interrupt pins and SPI.

The GD3162 is designed for high-functional safety integrity level systems (ASIL C/D) and meets the stringent requirements of automotive applications, being fully AEC-Q100 grade 1 qualified. NXP's EV traction inverter system solution features S32K39 multicore lockstep MCUs, FS26 safety SBCs, TJA1462 Signal Improvement CAN, TJA1103 Ethernet PHY and GD3162 high-voltage gate drivers to control power conversion to the traction motor with high efficiency and reliability.
NXP's system solution delivers a rich set of motor control software packages to accompany the optimized hardware.

The EV traction inverter system also provides precise control, monitoring and protection of high-power switches for energy efficiency and reliability. The system gives accurate and efficient motor speed and torque control and enables ASIL D compliance with ISO 26262 requirements.

To support customers in their traction inverter development and reduce time to market, NXP offers an easy-to-use EV Power Inverter Control Reference Platform with system enablement software. These design platforms include schematics, BoMs, layout files and safety documentation for use with either IGBTs or SiC MOSFET modules.

The GD3162 can be fully explored using the FRDMGD3162HBIEVM evaluation board (EVB). Users can evaluate different resistor values by changing the component on the EVB, and then test the various effects of the gate strength through the GD3162.

Summary

The innovation of a gate driver IC as the GD3162 with dynamic gate strength gives automotive OEMs an exciting new option to improve traction inverters. The dynamic gate drive function delivers optimal switching performance for advanced power switch devices (e.g. SiC, GaN) over increasingly wide operating ranges. Dynamic gate strength on the GD3162 boosts inverter efficiency, delivers a strong functional safety solution, and improves upon typical hardware design criteria to protect the power device.

Resources

- Gate Driver with dynamic gate voltage (GD3162) product page https://www.nxp.com/products/power-management/motor-and-solenoid-drivers/powertrain-and-engine-control/advanced-high-voltage-isolated-gate-driver-with-dynamic-gate-strength-control:GD3162
- Gate Driver with dynamic gate voltage (GD3162) fact sheet (PDF). https://www.nxp.com/docs/en/fact-sheet/GD3162FSA4.pdf
- Evaluation kit product page https://www.nxp.com/design/design-center/development-boards/analog-toolbox/gd3162-half-bridge-evaluation-kit:FRDMGD3162HBIEVM

www.nxp.com

How to Use GaN Power Devices for Superior Mid-Range Motor Inverters

The push for more efficient use of energy sources, stricter regulatory mandates, and the technical benefits of cooler operation all support recent initiatives to reduce the amount of power consumed by electric motors. While switching technologies such as silicon MOSFETs are widespread, they often cannot meet the critical inverter applications' more demanding performance and efficiency objectives.

By Rolf Horn, Applications Engineer at DigiKey Germany

Instead, designers can meet these goals using gallium nitride (GaN), a wide bandgap (WBG) FET device technology that has improved and advanced in terms of cost, performance, reliability, and ease of use. GaN devices are now mainstream and have become the preferred choice for inverters at mid-range power levels.

This article examines how the latest generation GaN-based FETs from Efficient Power Conversion Corporation (EPC) enable high-performance motor inverters. Evaluation boards are presented to help familiarize designers with GaN device characteristics and accelerate designs.

What is an inverter?
An inverter's role is to create and regulate the voltage waveform that drives a motor, which is often a brushless DC (BLDC) type. It controls motor speed and torque for smooth start and stop, reverse, and acceleration rate, among other requirements. It must also ensure that the desired motor performance is achieved and maintained despite changes in load.

Note that a motor inverter with variable-frequency output should not be confused with an AC-line inverter. The latter takes DC from a source such as a car battery to provide a fixed-frequency 120/240 volt AC waveform, which approximates a sine wave and can be used to power line-operated devices.

Why consider GaN?
GaN devices have attractive attributes relative to silicon, including higher switching speeds, lower drain-source on resistance (RDS(ON)), and better thermal performance. Lower RDS(ON) allows them to be used in smaller and lighter motor drives and reduces power losses, saving energy and cost in applications such as e-bikes and drones. Lower switching losses lead to more efficient motor drives that can extend the range of light electric vehicles (EVs). Faster switching speeds allow for low-latency motor response, essential for applications requiring precise motor control, such as robotics. GaN FETs can also be used to develop more powerful and efficient forklift motor drives. The higher-current handling capabilities of GaN FETs allow them to be used for larger and more powerful motors.

For end applications, the bottom-line benefits are reduced size and weight, higher power density and efficiency, and better thermal performance.

Getting started with GaN
Designing with any power-switching device, especially for mid-range currents and voltages, requires attention to the device's smallest details and unique characteristics. GaN devices have two internal structure options: depletion mode (d-GaN) and enhancement mode (e-GaN). A d-GaN switch is normally "on" and requires a negative supply; it is more complex to design into circuits. In contrast, e-GaN switches are normally "off" transistors, which results in a simpler circuit architecture.

GaN devices are inherently bidirectional and will start conducting once the reverse voltage across them exceeds the gate threshold voltage. Further, as they are not capable of avalanche mode operation by design, it is critical to have a sufficient voltage rating. A rating of 600 volts is generally adequate at bus voltages up to 480 volts for buck, boost, and bridge DC conversion topologies.

Although GaN switches are simple in their basic on/off power-switching functionality, they are power devices, so designers must give careful consideration to the turn-on and turn-off drive requirements, switching timing, layout, the impact of parasitics, control of current flows, and current-resistance (IR) drops on the circuit board.

For many designers, taking advantage of evaluation kits is the most effective way to understand what GaN devices can do and how to use them. These kits use individual and multiple GaN devices in different configurations and power levels. They also include the associated passive components, including capacitors, inductors, resistors, diodes, temperature sensors, protection devices, and connectors.

Start with lower-power devices
An excellent example of a lower-power GaN FET is the EPC2065. It has a drain-source voltage (VDS) of 80 volts, a drain current (ID) of 60 amperes (A), and an RDS(ON) maximum of 3.6 milliohms (mΩ). It is supplied only in passivated die form with solder bars and measures 3.5 × 1.95 millimeters (mm) (Figure 1).

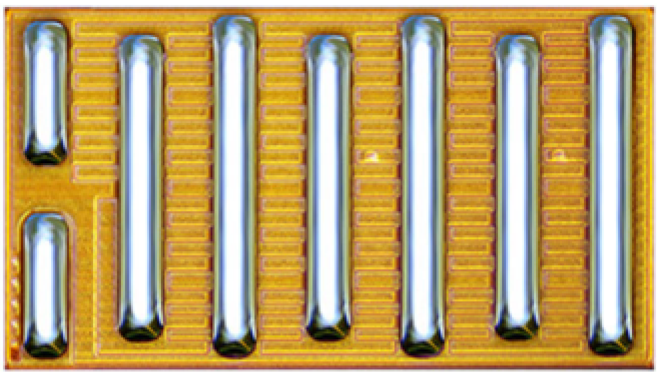
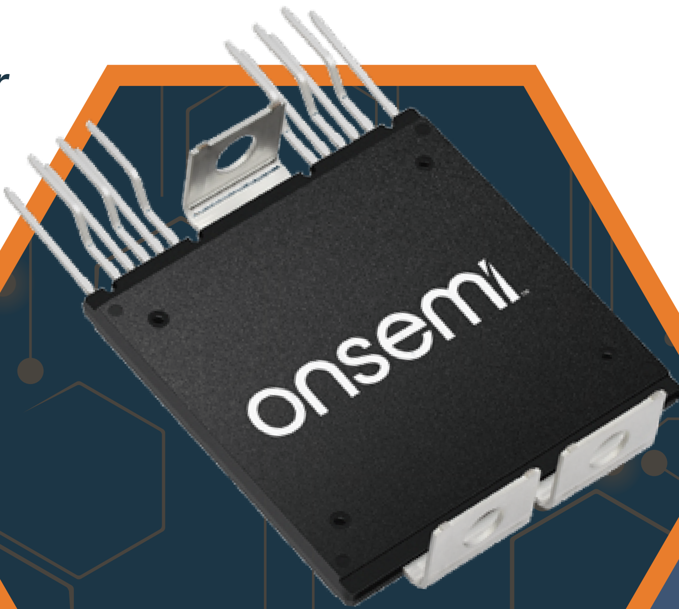


Figure 1: The 80 volt, 60 A EPC2065 GaN FET is a passivated die device with integral solder bars. (Image source: EPC)

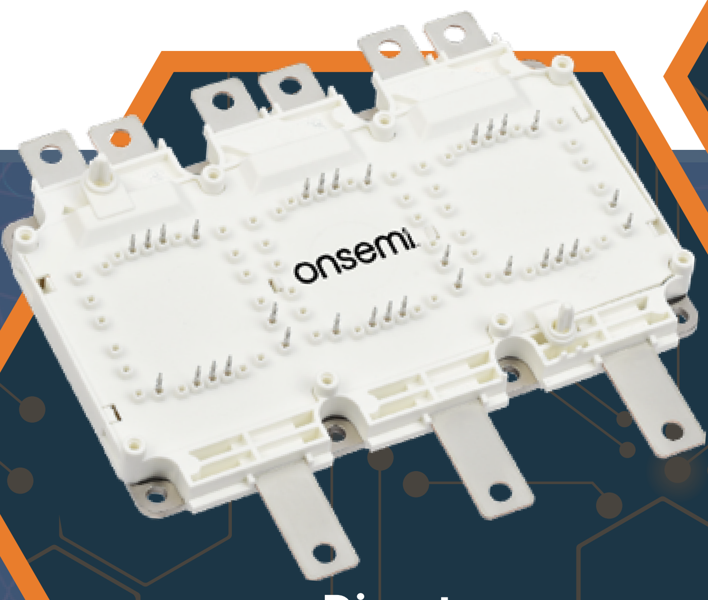
EliteSiC Technologies Accelerate Electrification Initiatives

EliteSiC Power Modules for Traction Inverter & On-Board Charger

At **onsemi**, optimized SiC solutions are in our DNA. Our concurrent development of dies and packages creates optimized solutions for our customers. We deliver advanced packaging materials and world-class thermal performance along with industry-leading die performance.



B2
(Single-Side Cooling, Half Bridge, 1200 V)



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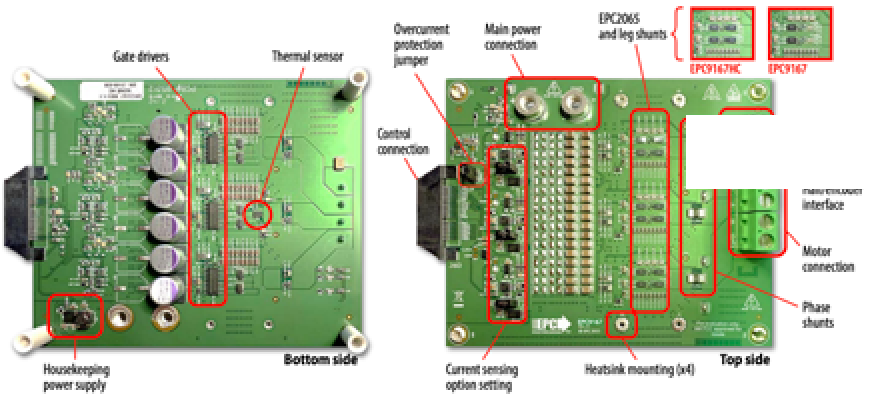

Figure 2: Shown are the bottom (left) and top (right) of the EPC9167 board. (Image source: EPC)

As with other GaN devices, the EPC2065's lateral device structure and majority carrier diode provide exceptionally low total gate charge (QG) and zero reverse recovery charge (QRR). These attributes make it a good fit for situations where very high switching frequencies (up to several hundred kilohertz) and low on-time are beneficial, as well as those situations where on-state losses dominate.

This device is supported by two similar evaluation kits: the EPC9167KIT for 20 A/500 watt operation, and the higher-power EPC9167HCKIT for 20 A/1 kilowatt (kW) operation (Figure 2). Both are three-phase BLDC motor-drive inverter boards.

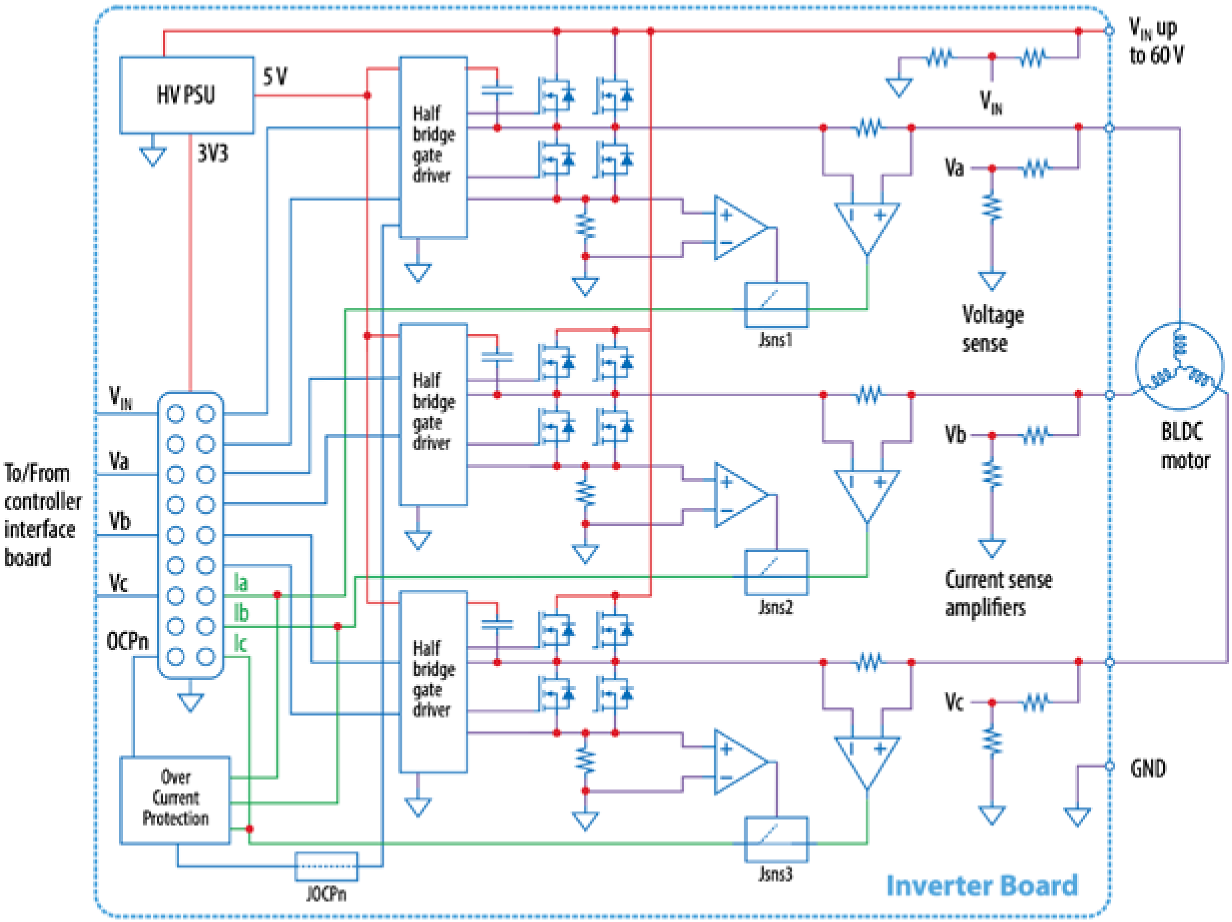

Figure 3: Shown is a block diagram of the base EPC9167 board in a BLDC drive application; the higher-power EPC9167HC has two EPC2065 devices in parallel for each switch, while the lower-power EPC9167 has only one FET per switch. (Image source: EPC)

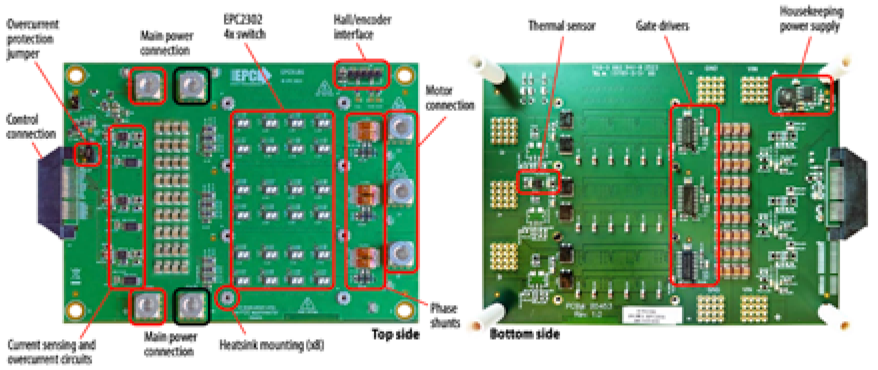

Figure 4: Shown are the top (left) and bottom (right) of the EPC9186KIT 5 kW evaluation board for the EPC2302. (Image source: EPC)

The basic EPC9167KIT configuration uses a single FET for each switch position and can deliver up to 15 ARMS (nominal value) and 20 ARMS (peak value) of current per phase. In contrast, the higher-current EPC9167HC configuration uses two parallel FETs per switch position and can deliver maximum currents up to 20 ARMS/30 ARMS (nominal/peak) output current, demonstrating the relative ease with which GaN FETs can be configured in parallel for higher output current. A block diagram of the base EPC9167 board is shown in Figure 3.

The EPC9167KIT contains all the critical circuits to support a complete motor-drive inverter, including gate drivers, regulated auxiliary power rails for housekeeping supplies, voltage sense, temperature sense, current sense, and protection functions.

The EPC9167 mates with assorted compatible controllers and is supported by various manufacturers. It can swiftly be configured as a motor-drive inverter by leveraging existing resources for quick development.

Going to higher power

At the other end of the power-handling range is the EPC2302, a GaN FET featuring a 100 volt/101 A rating and just 1.8 mΩ RDS(ON) maximum. It is well-suited to high-frequency DC-DC applications from 40 to 60 volts and 48 volt BLDC motor drives. In contrast to the passivated die packaging with solder bars used for the EPC2065, this GaN FET is housed in a low-inductance QFN package measuring 3 × 5 mm, with an exposed top for superior thermal management.

The thermal resistance to the case top is low at just 0.2°C per watt, which results in excellent thermal behavior and eases cooling challenges. Its exposed top enhances top-side thermal management, while the side-wettable flanks guarantee that the complete side-pad surface is wetted with solder during the reflow soldering process. This protects the copper and allows soldering on this external flank area for easy optical inspection.

The footprint of the EPC2302 is less than half the size of the best-in-class silicon MOSFET with similar RDS(on) and voltage ratings, while its QG and QGD are significantly smaller, and its QRR is zero. This results in lower switching losses and lower gate driver losses. The EPC2302 operates with a short deadtime in the tens of nanoseconds (ns) for higher efficiency, while its zero-value QRR enhances reliability and minimizes electromagnetic interference (EMI).

To exercise the EPC2302, the EPC9186KIT Motor Controller/Driver Power Management Evaluation Board supports motors up to 5 kW and can deliver up to 150 ARMS and 212 APEAK maximum output current (Figure 4).

To achieve this higher current rating, the EPC9186KIT uses four parallel GaN FETs per switch position, demonstrating the ease of using this approach to reach higher current levels. The board supports PWM switching frequencies up to 100 kHz in motor-drive applications, and contains all the critical functions to support a complete motor-drive inverter, including gate drivers, regulated auxiliary housekeeping power supplies, voltage and temperature sensing, accurate current sense, and protection functions.

Conclusion

Motor inverters are the critical link between a basic power source and a motor. Designing smaller, higher-efficiency, higher-performance inverters is an increasingly important objective. While designers have choices in process technology for the critical power-switching devices mid-range inverters use, GaN devices, such as those from EPC, are the preferred option.

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About the Author

Rolf Horn, Applications Engineer at DigiKey, has been in the European Technical Support group since 2014 with primary responsibility for answering any Development and Engineering related questions from final customers in EMEA, as well as writing and proofreading German articles and blogs on DK's TechForum and maker.io platforms. Prior to DigiKey, he worked at several manufacturers in the semiconductor area with focus on embedded FPGA, Microcontroller and Processor systems for Industrial and Automotive Applications. Rolf holds a degree in electrical and electronics engineering from the university of applied sciences in Munich, Bavaria and started his professional career at a local Electronics Products Distributor as System-Solutions Architect to share his steadily growing knowledge and expertise as Trusted Advisor.

EMI: The Prescription to Keep Noise Down in Medical Equipment

Why is Electro Magnetic Interference (EMI) a cause for concern? In electronics, EMI is unwanted noise caused by an electromagnetic field that may directly affect the performance of equipment and/or nearby equipment. It may also degrade the performance, cause malfunctions or even stop the equipment from functioning completely. In a medical environment, this can have very serious consequences, such as: generating erroneous measurement in patient monitors, impacting image quality radiography equipment, and affecting critical surgical systems and their operation.

By Dermot Flynn, Head of PLM, Excelsys and Ultravolt Products at Advanced Energy, and Paul Kingsepp, Product Line Manager at Advanced Energy

EMI, also known as Radio Frequency Interference (RFI), is nearly everywhere. For example, there are sources of EMI that occur in the natural world, such as lightning or radiation from the sun. Additionally, there are sources of man-made radiation that impact electrical equipment. Some of these are intentional, such as radio, TV and telephone. Others, however, are unintentional, such as sources from load distribution, vehicle ignition systems and even power supplies.

This article addresses these unintentional sources as they relate to power supplies, and, more importantly, how to eliminate them.

What makes power supplies noisy?

Any source of changing voltage or changing current with respect to time will result in ringing (switching noise that occurs due to parasitic components as currents are turned on and off) switch mode power supply will be full of these events as they occur every switching cycle and all tracks, points and components are a potential noise source. Within any given design there will be loops with rapid current and voltage rises and falls (respectively di/dt and high dv/dt). Figure 1, for example, identifies the potential areas for high di/dt in an isolated forward converter, while Figure 2 shows the potential areas for high dv/dt in the same design.

With such high di/dt and dv/dt, it's easy to generate significant common mode currents and voltage spikes of up to several volts, resulting in ground bounce, and hence, EMI. Another example would be a FET going from a V_{ds} of 200 volts in 40 ns. This equates to a dv/dt of 5 billion volts per second.

How to design to minimize emissions

It is practically impossible to eliminate EMI completely but for medical power supplies this challenge is greater. For example, conducted EMI is usually reduced by increasing Y-capacitance on the input of the power supply. However, increased Y-capacitance also increases leakage current, which is a critical safety specification for IEC 60601-1-2 compliance, as well as safeguarding patients and operators of the equipment.

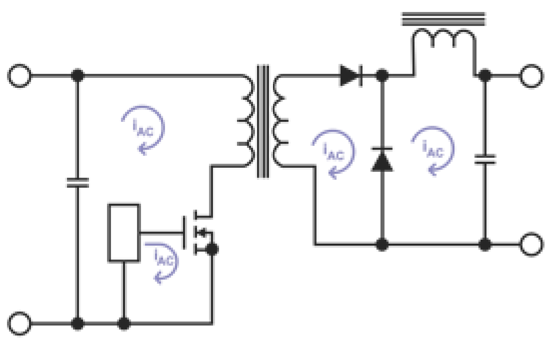


Figure 1: High di/dt loops on a forward converter

Designing power supplies for good EMI performance is not impossible. With the correct knowledge and experience, limiting EMI can be addressed during the project concept stage. This includes a heavy focus on the design and layout of the PCB, as it plays a significant role in emissions. The first focus is to eliminate, or at least minimize, the emissions from the source of the generators. It is important to consider that receivers also re-transmit, so minimizing the susceptibility of receivers is also necessary. Additionally, it is important to incorporate an EMI filter design, ideally, while keeping filters as physically small as possible, particularly for mobile and portable medical equipment.

PCB layout is often least understood when it comes to designing for EMI. Here are a few concepts to bear in mind:

- Minimize loop areas
- Leave no floating parts, ensuring that all loops are brought back to ground
- Keep signal and power ground connections separate

This adds complexity to the PCB design, particularly when it comes to saving layers on multi-layer PCBs whilekeeping signal and power grounds separate, keeping input and output grounds separate and minimizing distances from components. Earthing schemes were designed for safety purposes, not EMI, so using ground planes and short connections is vital.

Consider components with respect to frequency

The difficulty facing power supply designers is that EMI performance is usually not characterized by the component manufacturer, yet understanding the components is key to knowing how they will behave in a subsystem in terms of emissions. Capacitors, wire wound resistors and even wire leads will vary in behavior as the frequency changes. This also holds true for the type of capacitors used, as tantalum capacitors behave differently than ceramic capacitors. Furthermore, parasitic components, ESR (equivalent series resistance), ESL (equivalent series inductance),capacitancess, and leakage will all play their part, so knowing and quantifying these are all key to understanding EMI.

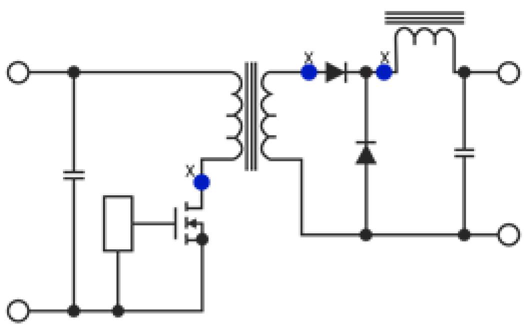


Figure 2: High dv/dt areas on a forward converter

The fact is that most EMC components are invisible on the circuit diagram as they are either stray and/or parasitic components, so particular attention must be paid to ensure everything is done with sound EMI/RF principles in mind.

Select a power supply with EMI margin

Testing the power supply for compliance at various limits does not guarantee that it will pass when installed into a system. The power supply is an active part in the system, which will affect system electronics and can itself be affected by other noise sources in the system. Selecting a power supply with good emissions and immunity performance will save on a lot of system compliance challenges later in the development.

Low emission power supplies can be produced if designed for EMI considerations from the start. For example, the NGB family of medically certified open-frame power supplies from Advanced Energy was specifically designed for exceptional EMI performance with reduced conducted and radiated emissions that simplify system EMI compliance.

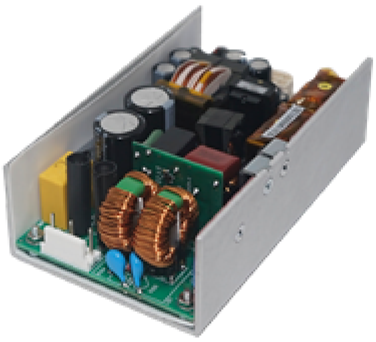


Figure 3: Advanced Energy's SL Power NGB425 Series

As Figure 4 shows, the NGB425, 425 W AC/DC power supply, delivers Class B conducted emissions with 6 dB margin and radiated emissions with 3 dB margin.

The NGB425 meets a range of immunity specifications to criteria A (no impact to performance) including:

- EN61000-4-2 Electrostatic Discharge Immunity, Level 4, 8 kV contact, 15 kV Air
- EN61000-4-3 Radiated RF EM Fields Susceptibility 10 V/m
- EN61000-4-4 Electrical Fast Transients / Bursts, Level 4, 4 kV
- EN61000-4-5 Surge, Level 4, 4 kV Line to Ground
- EN61000-4-6 Conducted Disturbances Induced by RF Fields, Level 4,
- EN61000-4-8 Rated Power Frequency Magnetic Fields Test, Level 4
- EN61000-4-11 Voltage Dips

In addition, the supply is safety certified to the IEC60601-1, third edition, with 2 x MOPP, with both Class I and Class II inputs.

Additional considerations

There are several other causes of poor system noise performance. Some of these are listed below:

- Insufficient de-coupling on the PCB or load
- Poor system earthing
- Faulty wiring connection or poor cable terminations

There are some simple steps to eliminate, reduce or identify the causes of high frequency noise. These include:

- Is the noise conducted or radiated? If changing the position of the power supply or screening improves performance, the noise is likely to be radiated.
- Ground connections (zero volt) should be made to the nearest point on the chassis.
- Twist all pairs of power and sense cables separately.

A common assumption is EMI emissions are highest at full load conditions or over a certain AC line voltage range. In reality, depending on the topology of the power supply, the emissions can vary significantly over line voltage and load range. In some cases, low load performance can be significantly worse than that at full load and low or high line voltage can be worse than the other. Recommendations are made on load and line conditions to perform the verification testing ensuring proper and thorough evaluation while also minimizing the tests required to achieve a high confidence level of compliance.

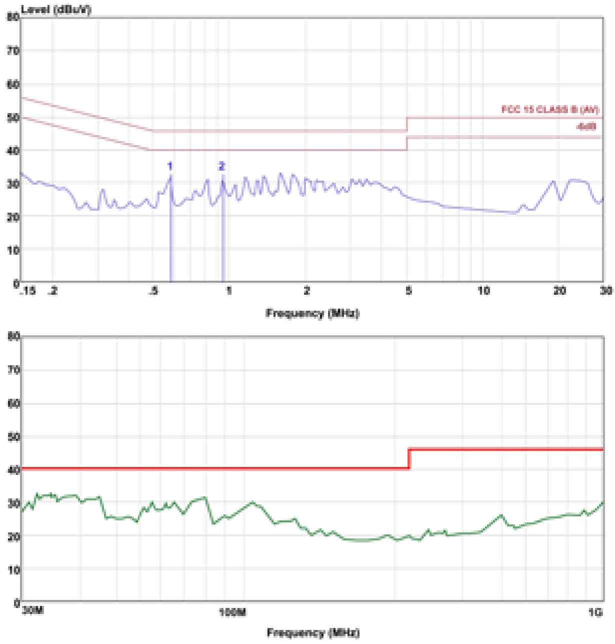


Figure 4: Conducted and Radiated EMI plots for NGB425

In the same way that power supply designers need to ensure that the sources for radiation are kept to a minimum, the system designers need to ensure that the overall system has optimum performance when fully integrated. Cabling arrangements and PCB tracking layouts are the greatest contributing factor to system-level EMC performance.

Conclusion

Power supplies are a critical safety component in medical equipment and are, by their nature, "noisy" electronics. However, selecting a power supply manufacturer that has designed EMI margin into their products, coupled with proven performance and medical applications experience, can help system designers meet their compliance obligations, while not compromising on size and performance.

EMI is considered by many as a challenge for medical equipment designers. Meeting safety compliance standards is non-negotiable, which can also directly impact system EMI performance. System EMI compliance can only truly be verified when the system design is fully completed, and at that time, trying to rectify non-compliance can negatively impact design time as well as the product launch plan.

Having the means to measure and mitigate EMI in a fully integrated system is a great time-to-market advantage. Using test and modify labs such as Advanced Energy's Customer Experience Centers (CECs) can support both design and EMI testing needs. Established EMI experts with a worldwide footprint, like AE, ensure there is a global team of subject matter experts ready to help. From pinpointing layout issues to pre-compliance testing for entire systems, the EMI experts at these global facilities can help meet system needs, deadlines and budgets.

www.advancedenergy.com

Save Space and Improve Efficiency with a 4-Switch Buck-Boost Controllers

A generation of 4-switch buck-boost controllers enables power system design with very high efficiency and high power density by using inductor DC resistance (DCR) current-sensing techniques. This article explains the benefits of inductor DCR current-sensing solutions vs. traditional solutions.

By Xu Zhang, Power Design Manager, Analog Devices

Introduction

The 4-switch buck-boost converter is popular and well-known for generating a regulated output voltage above, below, or equal to the input voltage. It also disconnects the input/output (I/O) during extreme fault conditions, such as the input short circuit or the output short circuit conditions. Together with overcurrent and overvoltage protections, 4-switch buck-boost converters are widely used in battery-powered devices, automotive systems, and general-purpose industrial applications.

New Technology: DCR Inductor Current Sensing

While prior 4-switch buck-boost controllers use external current-sensing resistors for current sensing, the LTC7878 is the first 4-switch buck-boost controller designed using inductor DCR for inductor current sensing. Implemented with a novel peak current mode control scheme, it has a built-in cycle-by-cycle peak current limit whether the regulator is in buck, boost, or buck-boost operation. From a wide 5 V to 70 V input voltage range, the output can be regulated from 1 V to 70 V with ±1% accuracy. By not requiring current-sensing resistors, the new buck-boost converter eliminates power loss and shrinks solution size. At the same time, it lowers the system cost by eliminating expensive high power current-sensing resistors. Inductor DCR current-sensing also provides continuous inductor current information, which enables unified peak current mode control and easy parallel operation in multiphase multi-IC configurations.

Inductor Current Sensing in 4-Switch Buck-Boost Converters

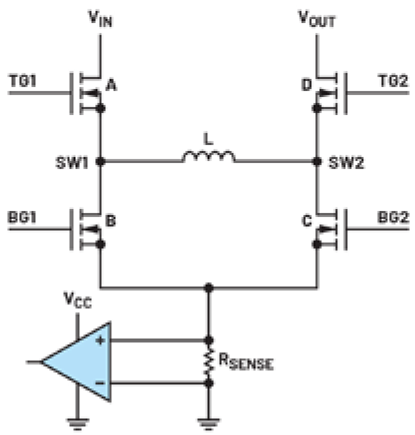


Figure 1: Ground-referenced current sensing in 4-switch buck-boost converters.

Many 4-switch buck-boost controllers require two or more current-sensing resistors to sense the I/O current and the inductor current for closed-loop operation. Analog Devices has unique buck-boost controllers that only require one current-sensing resistor to sense the current used in the current-mode control loop. Figure 1 shows a ground-referenced current-sensing method used in many traditional products. It is simple and easily implemented inside the IC. However, it can only sense the inductor current when Switch B or Switch C is turned on; this is the inductor valley current in the buck region or the peak current in the boost region, respectively. PCB layout options will be limited because the two MOSFETs (B and C) are both connected to the current-sensing resistor and must be placed close to each other.

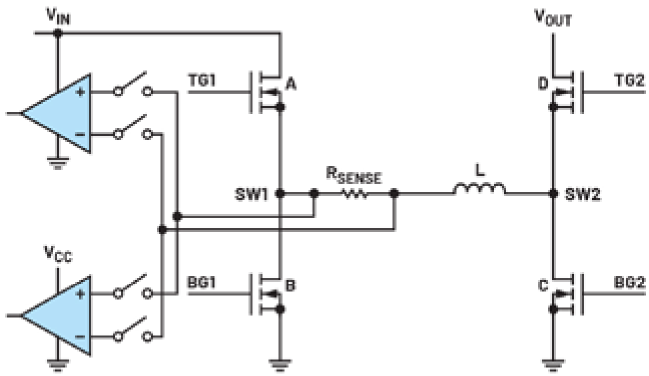


Figure 2: Switching node referred current sensing in 4-switch buck-boost converters.

Figure 2 shows a switching node referred current-sensing method used in some other buck-boost controllers. The current-sensing resistor is placed in series with the inductor, allowing it to sense the inductor current continuously. However, the voltage on the sensing resistor at the switching node swings up and down between the input voltage and ground when switches A and B are turning on/off. This requires the current-sensing circuit to have a very high common-mode rejection ratio (CMRR) to minimize the common-mode noise. Compared with tens of volts of common-mode voltage, the sensed inductor current signal is only in the range of 50 mV to 100 mV—a signal that could be easily distorted during power stage switching. To circumvent the noise, the current comparators are disconnected, and their inputs are turned off, as shown in Figure 2. Brief blanking times omit brief periods of inductor current information, even though the sensed signal is continuous.

Figure 3 shows the inductor DCR current-sensing method used in the LTC7878. By matching the time constant of the RC sensing network with the inductance and the DCR (L/DCR = Rs × Cs), the inductor current is converted to a voltage signal on the sensing network (Cs) and the gain is the DCR of the inductor. The current comparator is built under the BST1/SW1 circuit, which swings together with the VIN-GND switching node during operation. Due to the same common-mode voltage on the current comparator and the switching node, the current comparator inputs do not need to disconnect from the DCR sensing signal when SW1 switches. In this way, the inductor current is cycle-by-cycle regulated and limited continuously. Compared with the switching node referred current sensing, only a single comparator under BST1/SW1 is needed. Furthermore, an option to support different DCR values and cover various inductors is provided. For inductors with small DCR, the ISNSD pin may be set to amplify the signal and improve the signal-to-noise ratio (SNR) four times larger than the conventional DCR sensing scheme. The high SNR design significantly improves system reliability and provides stable switching operation across different duty cycles.

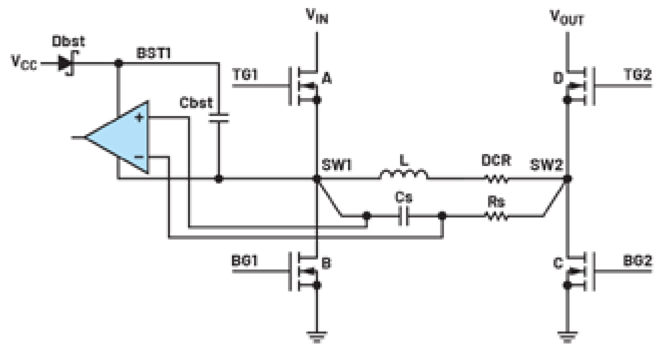


Figure 3:
Inductor DCR current sensing in 4-switch buck-boost converters.

Polyphase Parallel Operation

Inductor DCR current sensing together with continuous inductor current information allow a unified peak current mode control scheme to be implemented in the LTC7878. This scheme enables the polyphase operation, just as with many peak current mode buck or boost DC-to-DC controllers. Just by sharing all the ITH pins and daisy chaining all the CLKOUT pins, multiple LTC7878 devices can be paralleled together to supply more current to the load.

The load current is distributed evenly among all the channels, and the current sharing between inductors ensures thermal balance and high efficiency. The unique cycle-by-cycle inductor current sharing reduces the overcurrent stress on the inductors during startup and load transients, improving system reliability.

More Features

The switching frequency can be programmed between 100 kHz and 600 kHz or synchronized to an external clock. The integrated 7 V NMOS gate drivers can drive either logic level or nonlogic level MOSFETs. Other features include a smart external VCC bias pin, a PGOOD indicator pin, and selectable discontinuous conduction mode/continuous conduction mode (DCM/CCM) operation with different current limit settings. The LTC7878 can be used for inputs up to 70 V and for outputs programmable from 1 V to 70 V and it comes in a 5 mm × 5 mm QFN package.

Conclusion

The LTC7878 is a high performance 4-switch buck-boost controller with inductor DCR current sensing. It uses peak current mode control in buck, boost, or buck-boost regions and always provides cycle-by-cycle peak current limits and protections. By using inductor DCR current sensing, the solution provides high efficiency while lowering component cost. To maximize the power, multiple parts can easily work in parallel in polyphase architecture.

www.analog.com

About the Author

Xu Zhang received his B.S./M.S. degrees in electrical engineering from Tsinghua University, Beijing, China, in 2000 and 2003, respectively. He received a Ph.D. degree in electrical engineering from the University of Colorado at Boulder, Boulder, CO, USA, in 2009. In early 2010, Dr. Zhang joined Analog Devices where he designed many industry-first power controller ICs such as high voltage high power charge pump controllers, the novel hybrid buck controller with switched-capacitors, bidirectional buck controllers, and 4-switch buck-boost controllers. He is now leading the Power Controller Group and responsible for developing high performance silicon-based power regulators and controllers

Primary LDO Family for Automotive Applications

ROHM has developed 45 V rated 500 mA output primary LDO regulators, the BD9xxM5-C series. These devices are suitable for supplying power to automotive electronic components such as ECUs that operate from vehicle batteries. The BD9xxM5-C incorporates original QuiCurTM high-speed load response technology that is stated to deliver excellent response characteristics to load current fluctuations. For example, the LDO can maintain output to within 100 mV of set voltage even as the load changes between 0 and 500 mA in 1 µs (Rise time/Fall time). Furthermore, low 9.5 µA (typ.) current consumption contributes to lower power consumption in automotive applications. These products will be available in four packages, ranging from the compact HTSOP-J8 to the high heat dissipation TO252 (TO252-3/TO252-5) and HRP5 types. This allows users to select the most suitable package for each use case. The BD9xxM5-C meets the basic requirements for automotive products, including 150 °C operation and qualification under the AEC-Q100 automotive reliability standard. The lineup will be expanded to comprise a total of 18 models, (including the TO252-3, TO252-5, and HRP5 packages) by FY2024.

www.rohm.com

GaN for Low-cost E-Bikes, Drones, and Robotics

EPC now offers the EPC9193, a 3-phase BLDC motor drive inverter using the EPC2619 eGaN FET. The EPC9193 operates with a input DC voltage ranging from 14 V and 65 V and has two configurations – a standard unit and a high current version: While the EPC9193 standard reference design uses a single FET for each switch position for delivering up to 30 Arms maximum output current, a high current configuration version of the reference design, the EPC9193HC, uses two paralleled FETs per switch position with the ability to deliver up to 60 Apk (42 Arms) maximum output current. Both versions of the EPC9193 contain all the necessary critical function circuits to support a complete motor drive inverter including gate drivers, regulated auxiliary power rails for housekeeping supplies, voltage, and temperature sense, accurate current sense, and protection functions. The EPC9193 boards measure 130 mm x 100 mm (including connector).

Major benefits of a GaN-based motor drive are exhibited with these reference design boards, including lower distortion for lower acoustic noise, lower current ripple for reduced magnetic loss, and lower torque ripple for improved precision. The extremely small size of this inverter allows integration into the motor housing resulting in the lowest EMI, highest density, and lowest weight. EPC provides full demonstration kits, which include interface boards that connect the inverter board to the controller board development tool for fast prototyping that reduce design cycle times.

www.epc-co.com

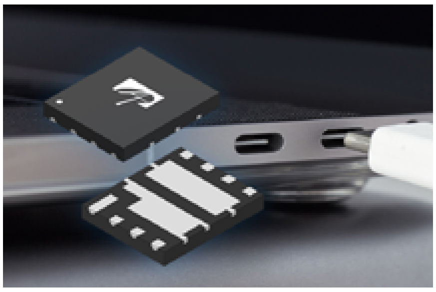
Reference Design for Qi2 Wireless Charging Implementation

As major charger manufacturers, including those in the automotive industry, are working to implement Qi® v2.0 (Qi2) standards, Microchip Technology has released a Qi 2.0 dual-pad wireless power transmitter reference design. Powered by a single dsPIC33 Digital Signal Controller (DSC), the Qi2 reference design offers efficient control for optimized performance. A key feature of the new Qi2 standard, recently released by the Wireless Power Consortium (WPC), is the introduction of a Magnetic Power Profile (MPP) with support for magnetic alignment between the transmitter and the receiver. The DSC's flexible software architecture enables the support of a combination of MPP and Extended Power Profile (EPP) of Qi 2.0 with one controller. Utilizing the Qi2 reference design helps minimize customer risk in certifying their final product, which is required to pass through the Qi certification process. As it integrates several of Microchip's automotive-qualified parts, the dual-pad charger also meets automotive standards for reliability and safety and supports Autosar®. An integrated CryptoAuthenticationTM IC provides security to meet the stringent authentication requirement of Qi standards. The reference design is hardware reconfigurable and capable of supporting most transmitter topologies.

www.microchip.com

Buck-Boost MOSFET for Higher Power USB PD 3.1 EPR Applications

Alpha and Omega Semiconductor announced its AONZ66412 XSPairFET MOSFET designed for Buck-Boost converters in USB PD 3.1 Extended Power Range (EPR) applications. The USB PD 3.1 EPR increases the USB-C maximum power up to 240 W. AONZ66412 is defined to support the most commonly addressed power range of up to 140 W at 28 V, with two 40 V N-Channel MOSFETs in a half-bridge configuration in a symmetric XSPairFET 5 mm x 6 mm package. The AONZ66412 can replace two single DFN5x6 MOSFETs. The AONZ66412 is suited for buck-boost converters in Type-C



USB 3.1 EPR applications, including notebook, USB hub, and power bank designs. The AONZ66412 is an extension to the AOS XSPairFET™ lineup. The improved package parasitics make 1 MHz operation achievable, allowing inductor size and height to be reduced. AONZ66412 has been tested to achieve 97% efficiency @1 MHz in typical USB PD 3.1 EPR conditions of 28 V input, 17.6 V output, and 8 A load conditions.

www.aosmd.com

Family of Power Analyzers

A family of Rohde & Schwarz power analyzers is now available in three models to meet the requirements for measuring voltage, current, power and total harmonic distortion on both DC and AC sources. The R&S NPA101 power meter provides all basic measurements, the R&S NPA501 power analyzer adds enhanced measurement functions and graphical analysis, and the R&S NPA701 compliance tester includes evaluation functions in line with IEC 62301 and EN 50564 for power consumption and EN 61000-3-2 for EMC harmonic emission testing.

All models of the R&S NPA family of power analyzers meet the requirements of these stages for power measurements at levels from 50 µW to 12 kW, at potential differences from 1 mV to 600 V and currents from 1 mA to 20 A. The R&S NPA501 and R&S NPA701 include interfaces for external probes or shunts to further extend the range. All three models feature a sampling rate of 500 ksample/s. The 16-bit resolution A/D convertor provides an accuracy of ± 0.05 % for both current and voltage readings. The three instruments of the R&S NPA family include the same 23 standard measurements of power, current, voltage, harmonic distortion and energy.

www.rohde-schwarz.com

Generators and Multimeters added to portable Instrument Family

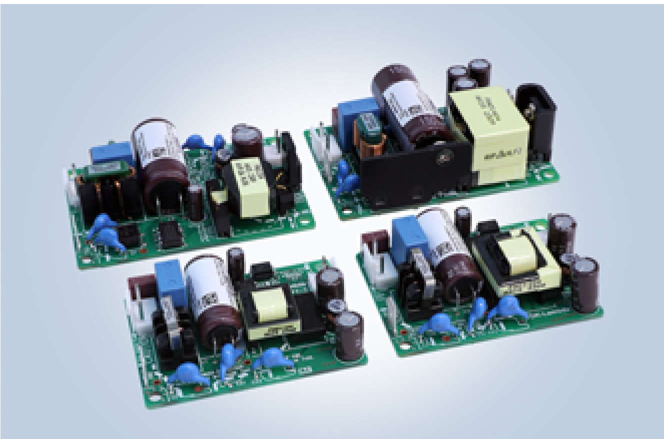
Rigol Technologies is expanding its family of portable instruments with the introduction of the DG800 Pro and DG900 Pro Series Function / Arbitrary Waveform Generators, along with the DM858 Series Digital Multimeters. The DG800 Pro and DG900 Pro Series Function/Arbitrary Waveform Generators include the capabilities of noise generator, pulse generator, harmonic generator, analog/digital modulator, and frequency counter. They deliver up to 200 MHz maximum output frequency, 1.25 GSa/s sample rate, 16-bit vertical resolution, and 3 ns rise time in a chassis with a 7 inch color touch display.

The DM858 Series is a benchtop 5.5 digit DMM with 7 inch color touch display. It provides 11 measurement functions and offers trend chart, histogram, and bar table visual display options, while providing competitive specifications, including 125 rdgs/s measurement speed and 500,000 points memory logging. Each unit is designed to comply with VESA 100x100 mounting, allowing the use of stands or movable arm mounts. The instruments include a Type-C interface, so the combination of their light weight (less than four pounds) and commercially available power banks make for an easy shift from the lab to the field.

www.rigol.com

Industrial AC/DC Power Supplies

TDK Corporation introduced its ZWS-C series of 10, 15, 30 and 50 W rated industrial AC/DC power supplies. The products meet EN55011/EN55032-B conducted and radiated EMI in either a Class I or Class II (double insulated) construction, without the need for external filtering or shielding. With electrolytic capacitor lifetimes of up to 15 years, the ZWS-C can be used in factory automation, robotics, semiconductor fabrication manufacturing and test and measurement equipment. Available output voltages are 5 V, 12 V, 15 V, 24 V as well as 48 V for the ZWS50-C model only. The ZWS10-C and the ZWS15-C models measure 63.5 x 45.7 x 22.1 mm^3 (L x W x H), the ZWS30-C 76.2 x 50.8 x 24.2mm^3, and the ZWS50-C 76.2 x 50.8 x 26.7 mm^3. The operating temperature with convection cooling and standard mounting is -10 oC to 70 oC derating linearly to 50% load above 50 to 70 °C. With an external airflow of 0.8 m/s, the power supplies can operate at full load. No load power consumption is typically less than 0.3 W. The power supplies have a 3 kVac input to output, 2 kVac input to ground and 750 Vac output to ground (Class I) isolation. All models are certified to the IEC/UL/CSA/EN62368-1 for AV, information and communication equipment standard and EN60335-1 for household electrical equipment.



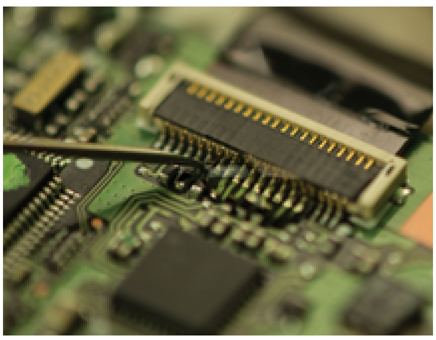
www.tdk.com

Underfill Epoxy Offers High Transition Temperature and Low Viscosity

Master Bond EP114 is a two component, low viscosity, NASA low outgassing rated, heat cured epoxy that can be effectively utilized for underfill, coating, impregnating and porosity sealing applications. This optically clear compound features high dimensional stability due to its nano-silica filler material. It has been successfully tested for abrasion resistance per ASTM D4060-14 and readily withstands 1,000 hours at 85°C and 85% relative humidity.

EP114 has excellent electrical insulation properties with a volume resistivity greater than 1014 ohm-cm and a dielectric constant of 3.35 (60Hz) at 25°C. This system features an exceptionally low coefficient of thermal expansion of 20-22 x 10-6 in/in/°C along with a compressive strength of 24,000-26,000 psi, an ultra-high modulus of more than 1,000,000 psi and a hardness of 85-95 Shore D at 25°C. Also, it has a glass transition temperature of more than 200°C.

EP114 features excellent flow properties with a mixed viscosity of 500-1,500 cps. It offers a long working life after mixing, for example a 100-gram batch at 25°C will yield an open time of 2 to 4 days. The system requires heat for curing. One of the many recommended cure schedules is 2 to 3 hours at 125°C followed by 5-8 hours at 150°C, with a 2 hour or longer post cure at 150-200°C. It is available in various packaging options: syringe kits, 1/2-pint kits, pint kits, and quart kits. It can also be packaged in pre-mixed and frozen syringes, which require storage at -40°C and are suitable for automated dispensing.



www.masterbond.com

100 V Trench Schottky Rectifier Diodes

STMicroelectronics has introduced 100 V trench Schottky rectifier diodes increasing efficiency in power converters operated at high switching frequencies. ST's trench Schottky diodes are claimed to "significantly reduce the rectifier losses, with superior forward-

voltage and reverse-recovery characteristics that enable increased power density with high efficiency." The forward voltage is said to be "50-100 mV better than in comparable planar diodes", depending on current and temperature conditions. Changing to these devices might increase the efficiency by 0.5%. There are 28 variants in the family, with eight current ratings from 1 A to 15 A, multiple surface-mount packages, in industrial and automotive grades. The industrial-grade parts target applications such as miniature switched-mode power supplies and auxiliary power supplies for telecom, server, and smart-metering equipment. In automotive, typical uses include space-constrained applications such as LED lighting, reverse-polarity protection, and low-voltage DC/DC converters. The parts are AEC-Q101 qualified, manufactured in PPAP-capable facilities, and specified from -40 °C to 175 °C. The diodes are 100% avalanche tested in production.

www.st.com

Automotive N-Channel MOSFETs for 48 V Applications

Toshiba has launched two automotive N-channel power MOSFET devices to meet the growing demand for 48 V batteries and systems within automotive applications including inverters, semiconductor relays, load switches, motor drives and more. The 80V

XPQR8308QB and 100V XPQ1R00AQB are based upon Toshiba's U-MOS X-H process. This gives low levels of on-resistance with the XPQR8308QB measuring less than 0,83 mΩ while the XPQ1R00AQB does not exceed 1,03 mΩ. The devices are rated for I_D values of 350 A (XPQR8308QB) and 300 A (XPQ1R00AQB) continuously with pulsed values (IDP) of 1050 A and 900 A respectively. Supporting these values, the L-TOGLTM package adopts a thick copper clip-based leadframe structure that thermally and electrically connects the MOSFET die to the package leads. This reduces the package resistance by approximately 70% and channel-to-case thermal impedance by 50% compared with the TO-220SM(W) package. Together, the process and clip reduce losses and heat generation while creating a very thermally efficient solution. Furthermore, the L-TOGL package uses compliant gull-wing leads which reduce mounting stress and improve the reliability of solder joints. Both devices are AEC-Q101 qualified for automotive applications. Toshiba offers to ship devices grouped to within 0.4V based upon their gate threshold voltage.

www.toshiba.semicon-storage.com

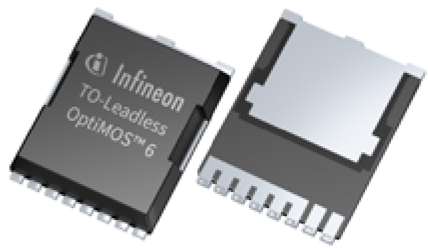
Supercapacitors with 3 Cells

Knowles Precision Devices announced Electric Double Layer Capacitor (EDLC), or supercapacitor, modules using a three-cell package for higher operating voltages and printed circuit board space savings. Their large capacity makes it possible to support brief power interruptions, supplement batteries, or even to be used in place of batteries in several applications. These supercapacitors are suited for applications including solar and wind energy harvesting, mechanical actuators, AGV (Automated Guided Vehicles), EV transportation power, smart utility meters, IoT, pulse battery pack alternatives, memory backup, battery/capacitor hybrids, UPS systems, emergency lighting, LED power, solar lighting or anywhere that significant energy storage is needed. The supercapacitors offer a notable jump in voltage rating over typical radial-mount supercapacitors, up to 9.0 WVDC. A key feature of the DGH and DSF Series additions is the unique three-cell radial-leaded package. Both series include capacitance values from 0.33 to 5 Farads. Multiple devices can be banked for even higher capacitance or voltage. In addition, these supercapacitors perform their internal cell balancing with operating temperature ranges from -40 °C to +65 °C for DGH

8.1V/DSF 9.0V and -40 °C to +85 °C for DGH 6.9V/DSF 7.5V. They are designed to withstand over 500,000 charge/discharge cycles.

www.cde.com

200 V MOSFETs stated to set a new Industry Benchmark



Infineon claims that motor drive applications are taking a leap forward with the launch of the company's OptiMOS 6 200 V MOSFET product family. The portfolio is designed to deliver high performance in applications such as e-scooters, micro-EVs, and E-forklifts. The improved conduction losses and switching behavior for these MOSFETs reduce the electromagnetic interference (EMI) and switching losses e. g. in applications like servers, telecom, energy storage systems, audio and solar. Additionally, the combination of a wide safe operating area (SOA) and "industry-leading R_{DSon}" fits to static switching applications such as battery management systems.

With the introduction of the OptiMOS 6 200 V product family, Infineon claims to set "a new industry benchmark with increased power density, efficiency, and system reliability". Compared to its predecessor, OptiMOS 3, OptiMOS 6 200 V features a 42 percent lower R_{DSon} and a diode behaviour softness, which is more than three times that of the OptiMOS 3. Combined with up to 89 percent reduction in Q_{RRtyp}, the switching and EMI behaviors are significantly improved. The technology also features improvements in parasitic capacitance linearity (C_{oss} and C_{rss}), which reduces oscillation during switching and lowers voltage overshoot. A tighter V_{GSth} spread and lower transconductance aid in MOSFET paralleling and current sharing, leading to more uniform temperatures and reducing the number of paralleled MOSFETs.

www.infineon.com

Polyimide Coated Magnet Wires for >800 V

Electrical breakdown of high-temperature insulation materials can be prevented by using thermoplastic Polyimide, TPI. This polymer can be extrusion-coated as other polymers, but AURUM®, TPI reduces electrical and magnetic losses. With 245 °C AURUM claims to have the highest Tg of any commercially available Thermoplastic, and its insulation performance especially at temperatures above 150 °C is stated to beat any other know insulation. AURUM reduces electrical and magnetic losses with a comparative tracking index (CTI) of > 600 volts. Thermoplastic Polyimide (TPI) produced by Mitsui Chemicals of Japan, and sold by BEIGLO GmbH is known for its thermal stability, high-temperature resistance, and electrical insulation properties. TPI coated magnet wires are a suitable choice for high-voltage applications (800 V and above).

www.bieglo.com

Resettable Thermal Cutoff Devices

Bourns announced some miniature resettable thermal cutoff (TCO) device series, also known as mini-breakers, that are designed to control abnormal, excessive current virtually instantaneously, up to rated limits. The Model NX Series offers higher current-carrying capabilities combined with a very low-profile package at a height of 0.94 mm and body width of 2.8 mm. These features make this series an ideal overtemperature and overcurrent protection solution for lithium polymer and prismatic cells in high energy density, smaller batteries such as next-generation notebook PC and tablet battery cells, as well as handheld and wearable electronics. With the same footprint as the company's model NR series the model NX series can carry 40 percent more current.

The Model NX Series has current capabilities from 12 A to 20 A at 60 °C and is available with or without welding projections. These TCO devices are available with four trip temperature options of 77 °C, 82 °C, 85 °C and 90 °C - all of which operate within a ±5 °C tolerance. The Model NX Series also is designed with a high-rated corrosion resistant bimetal mechanism that delivers enhanced endurance in humid environments compared to standard TCO devices.

www.bourns.com

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