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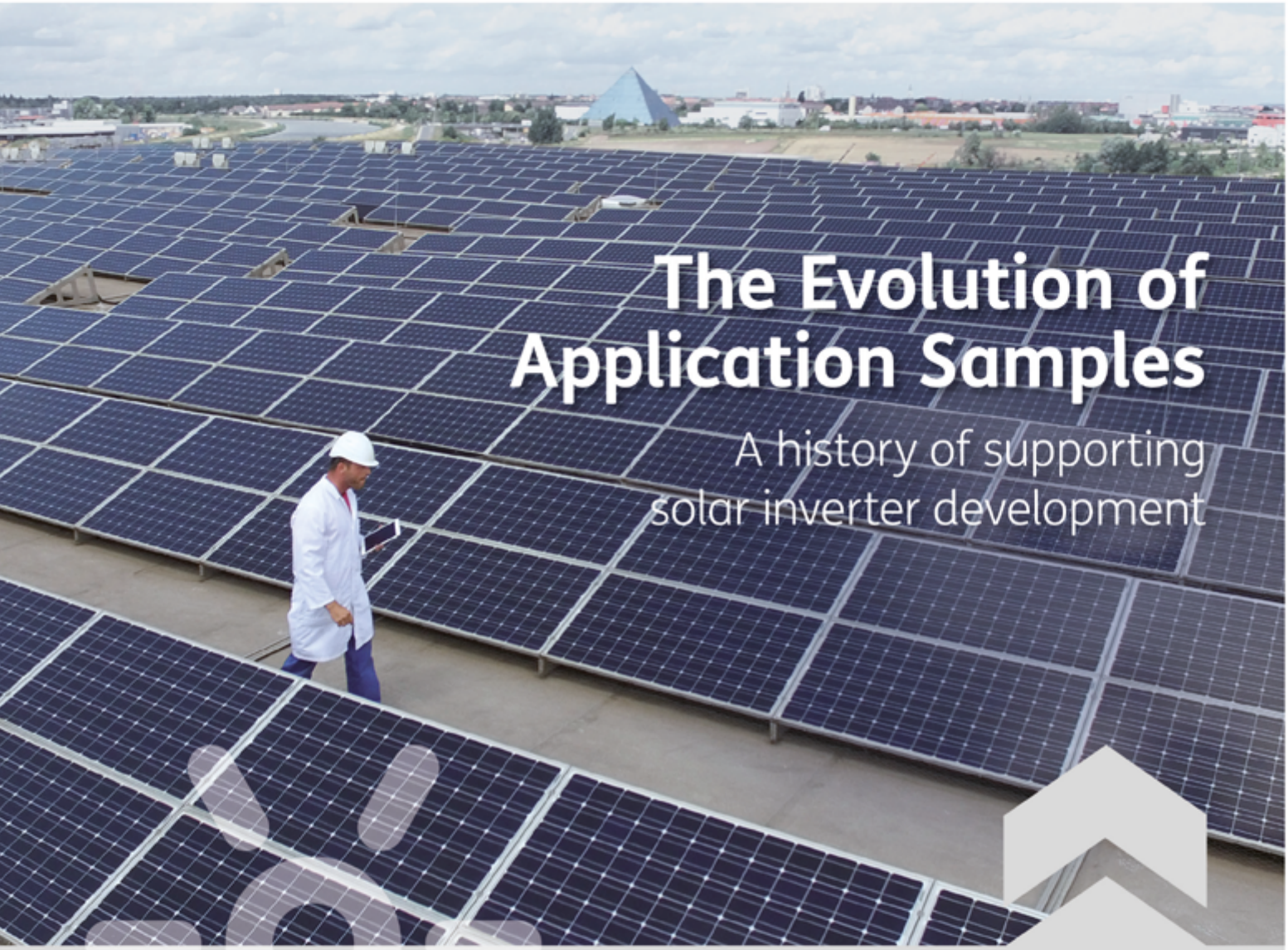
Bodo´s Power Systems®

Electronics in Motion and Conversion

June 2022



The Evolution of Application Samples

A history of supporting solar inverter development

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 $L_{inc}(\int Udt)$
- **Secant inductance** $L_{sec}(i)$ and $L_{sec}(\int Udt)$
- **Flux linkage** $\psi(i)$
- **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
DPG10-1500B	1 to 1500A	1350J
DPG10-1500B/E	1 to 1500A	2750J
DPG10-3000B/E	3 to 3000A	2750J
DPG10-4000B/F	4 to 4000A	7700J
DPG20-10000B/G	10 to 10000A	15000J

Technological leader in pulsed inductance measurement for 18 years

www.ed-k.de

Content

Supporters & Friends

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

AFRAID OF INRUSH CURRENT?

SELECT EMC FERRITES BY PEAK PULSE

WE meet @ Embedded World

Hall 2, Booth 110

REDEXPERT.
Würth Elektronik's online platform for simple component selection and performance simulation:
www.we-online.com/redexpert

- Pulse Designer for EMC PCBFerrites to meet inrush current requirements based on inrush current amplitude and pulse length
- The world's most accurate AC loss model
- Filter settings for over 20 electrical and mechanical parameters
- Inductor simulation and selection for DC/DC converters
- Ability to compare inductance/current and temperature rise/DC current using interactive measurement curves
- Available in seven languages
- Online platform based on measured values
- Order free samples directly
- Direct access to product datasheets
- Comfortable and clear component selection

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A Successful Return

In mid-May our family business finally returned to Nuremberg for PCIM and it certainly had the spirit of a huge family reunion. I spoke to so many people and nobody regretted being there, the event was a total success! Everybody was so happy to be back, the halls quickly filled with visitors and the booths were just how you would have expected them to look, modern and packed with the latest products and technologies, as well as highly motivated staff representing their companies. One of my personal highlights was a wirelessly powered flat screen TV, which could be moved seamlessly on the charging surface. As I hate cables and cords in my home, that really caught my attention. Also, I have to mention the countless sessions on the industry, e-mobility, and exhibitor forums. They were all well attended and Bodo's sessions on Wide Bandgap were no exception. It was like in past years, if you wanted a seat, you had to arrive early and I noticed that many of those people standing also stayed for the whole talks. That's the passion for power! A huge 'Thank You' from our team goes to all the presenters at Bodo's podiums. You have all qualified for next year, watch out for the invitations coming your way. Hopefully we will have some more seats available in 2023, so we can invite even more speakers! In the meantime, and for those who still don't like to travel, Bodo's virtual WBG Expert Talk is the perfect way to stay updated on SiC and GaN digitally. Also, we are planning our WBG event in December again. This will keep us busy over the summer, so watch out for news on this event.

During the many conversations at Nuremberg, in addition to all of the new products and other announcements, one topic was frequently discussed: the lack of new blood coming into engineering and the lack of young talent available. Some of the executives, that I had the honor to speak to, are even afraid that this trend is going to be here for a while. With this in mind, it was good to see the traditional 'students' day' on Thursday was held again. And there were noticeably more young people around on the last day of the event. The way we work has changed a lot, especially over the last years with the pandemic. Young people have different expectations on their working live. This war on talent is not new, and it will go on, that's for sure. Companies don't choose employees any more, qualified applicants choose the company they want to join!

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 my magazine with every single issue is available for free at my website bodospower.com.

My Green Power Tip for the Month:
Make as much use as possible from the gifts you received at the show. Sustainability not only means buying things that are branded sustainable, but also using the ones that exist already. Producing them consumed energy and resources!

Best regards

Events

IEEE VLSI 2022
Honolulu, HI, USA June 13 – 17
www.vlsisymposium.org

IEEE GPECOM 2022
Cappadocia, Turkey June 14 – 17
https://gpecom.org/2022

Battery Electric Vehicle Architectures 2022
Detroit, MI, USA June 21 - 22
www.beva-usa.com

PEMD 2022
Newcastle, United Kingdom June 21 – 23
https://pemd.theiet.org

embedded world 2022
Nuremberg, Germany June 21 – 23
www.embedded-world.de

SEMICON Southeast Asia 2022
Penang, Malaysia June 21 – 23
www.semiconsea.org

PEDG 2022
Kiel, Germany June 26 – 29
www.pedg2022.org

EV Tech Expo Europe 2022
Stuttgart, Germany June 28 – 30
www.evtechexpo.eu

The Battery Show Europe 2022
Stuttgart, Germany June 28 – 30
www.thebatteryshow.eu

munich expo

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- Charging & Energy
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- Automated Driving & Elekctronics
- Battery & Powertrain
- Mobility Concepts & Services
- Special Award: Student

Bild: Kroha Fotografie

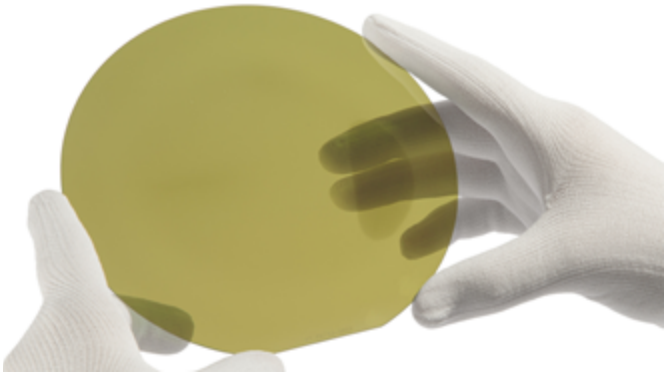
eMove360° trade fair goes Berlin

eMove360° Europe 2022
Messe Berlin, 5 - 7 October 2022

Application Deadline July 31 2022
More information: www.emove360.com

Celebrating 25 Years of High-tech from Nuremberg

SiCrystal is celebrating its 25th anniversary. Over the last two and a half decades, the company – which today employs over 200 people – has expanded its sphere of activity to an international level: a small but important piece of technology made in Franconia can be found in electric vehicles all over the world, for example. After all, it is often the little things that make big things happen. Based at Nordostpark industrial park in the north east of Nuremberg, Germany, the manufacturing company is one of the current global market leaders for single crystalline silicon carbide semiconductor wafers (SiC wafers).



"25 years of company history really is something to celebrate," says CEO Robert Eckstein, looking back on the beginnings of SiCrystal. The company has been producing SiC wafers since April 1997. The wafers form the basis for modern electronic components and resemble "a CD without a hole". They are almost as hard as a diamond and very heat resistant. Without these discs – which are less than 1 millimeter thick – electric mobility and the digital world would be unthinkable.

Research carried out at the University of Erlangen in the early 1990s laid the foundation for the company and, in 1997, SiCrystal AG was founded. Back then, it all began with the development and sampling of the first SiC wafers in Eschenfelden, Upper Palatinate. The semiconductor manufacturer then moved back to Erlangen in the early 2000s and was taken over by the Japanese ROHM Group – manufacturer of electronic components – in 2009.

www.rohm.com

Driving the Adoption of Wide Bandgap Technologies

Navitas Semiconductor has announced its membership of PowerAmerica, the consortium working to accelerate the adoption of next generation GaN and silicon carbide (SiC) power electronics. As a member of PowerAmerica, Navitas will provide input into initiatives to help companies that use power semiconductors to upgrade beyond legacy silicon, and access resources and relationships contributing to business growth. "The upgrade from legacy silicon to WBG semiconductors is critical to supporting environmental goals by dramatically reducing power consumption and accelerating the adoption of sustainable technologies," said Dan Kinzer, Navitas' COO/CTO and co-founder. "The consortium's membership network of entrepreneurs, technologists and academic partners is helping to drive this revolution and we are excited to be part of this increasingly-important eco-system."

Navitas Sr Director of Marketing, Llew Vaughan-Edmunds, is currently the chairman of PowerAmerica and will lead the MAC meeting during the PowerAmerica 2022 Summer Workshop on NC State Campus in Raleigh, NC on August 2nd. Navitas will host a technology seminar at the workshop to introduce leading-edge GaNFast power ICs with GaNSense™ technology, and stress high-quality, high-capacity manufacturing with over 40,000,000 units shipped and zero reported GaN-related field failures.

www.navitassemi.com

Andreas Urschitz Appointed as Chief Marketing Officer

Andreas Urschitz, currently President of the Power & Sensor Systems (PSS) Division, has been appointed as Helmut Gassels successor as Chief Marketing Officer of Infineon. Adam White, currently CMO of the PSS Division, is the designated President of the Division.

"As a longtime companion, Helmut Gassel has played a decisive role in Infineon's great success. As CMO, he has driven forward the digitalization of marketing and sales and thus the alignment with the future. I view with great respect the fact that he wants to make a personal change and therefore leave Infineon. I welcome the Supervisory Board's decision in favor of Andreas Urschitz as the future CMO. He has achieved great success as Division President and has demonstrated a keen sense of market developments and our customers' needs," said CEO Jochen Hanebeck.

"Together with our customers, Infineon employees are driving the decarbonization and digitalization of everyday life. I am very much looking forward to helping shape the path to a livable future now as part of the Management Board team," said Andreas Urschitz, President of the PSS Division and designated CMO of Infineon.

Andreas Urschitz has been President of the Power & Sensor Systems (PSS) Division since 2012, which serves the market with a wide range of power semiconductor, radio frequency and sensor technologies. Prior to the role as head of the PSS Division, Mr. Urschitz held various management positions in production, marketing, development and sales. He began his career at Infineon (until 1999 Siemens AG) in Villach, Austria, after studying business economics and subsequently teaching at the Vienna University of Economics and Business Administration.

www.infineon.com

ROHM
SEMICONDUCTOR

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ROHM'S GEN 4 SiC POWER DEVICES

As a technology leader ROHM is contributing to the realization of a sustainable society by focusing on the development of low carbon technologies for automotive and industrial applications through power solutions centered on SiC Technology. With an in-house vertically integrated manufacturing system, ROHM provides high quality products and stable supply to the market. Take the next development step with our Generation 4 SiC power device solutions.

Industry-leading low ON resistance

Reduced ON resistance by 40% compared to previous generation without sacrificing short-circuit ruggedness.

Minimizes switching loss

50% lower switching loss over previous generation by significantly reducing the gate-drain capacitance.

Supports 15V Gate-Source voltage

A more flexible gate voltage range 15 -18V, enabling to design a gate drive circuit that can also be used for IGBTs.

www.rohm.com

EPE'22 ECCE Europe: In-Presence Conference

EPE'22 ECCE Europe will take place from Tuesday September 6 to Thursday September 8 as an in-presence event and will bring together experts from industry and academia to a real and direct face-to-face discussion. On Monday September and Friday, Tutorials will take place in the rooms of Leibniz University Hannover. This assures you can select from a larger choice and attend more of the attractive Tutorials given by high-ranking specialists in their fields of expertise.

The layout of the conference has been adjusted in order to underline the importance of our Dialogue Sessions. That's why we moved them to the centre of our conference. The dialogue sessions will take place around mid-day of all three main conference days. They will take place in the same hall as the exhibition, which is therefore also receiving highest attention possible. The conference will highlight the Focus Topics 'New Power Electronic Devices', 'Integration and Adverse Effects of WBG Devices', and 'Batteries in Power Electronics' and cover the latest technology trends that will be driving future innovation in power electronics, while the Application Focus topics cover important application trends that will have a tremendous impact on future markets and requirements for power electronic systems. Daily social activities like the IEEE PELS Young Professionals (YP) Reception complement the event.

https://epe2022.com

Integrating Renewables and Stabilizing the Grid

With more intermittent renewable energy generation on the world's power networks, and fossil fuel supplies experiencing major disruptions, distributed power reserves are becoming increasingly important to maintain grid stability and keep the power on 24/7. To support this transition, ABB is launching PowerExchanger, an innovative feature for its UPS products, which allows battery reserves to provide ancillary services to the grid, reducing costly downtime and cutting energy and operating costs.

UPS equipment is used to provide back-up power in the case of a grid supply failure, and it can also eliminate brownouts, over-voltages, and electrical noise. The UPS' back-up power is drawn from its energy storage capacity, which often goes unused. With PowerExchanger fitted to new or existing ABB UPS systems, these batteries can be used to help the grid respond quickly to unexpected imbalances between power generation and demand, to reduce costly outages.

By using PowerExchanger to join markets for grid ancillary services, for example Fast Frequency Response (FFR), operators can now generate a new revenue stream, which lowers the cost of operating this capital-intensive equipment. Ideal for Low and Medium Voltage data centers, PowerExchanger ensures a minimum energy reserve

is retained by the UPS battery, so in the event of a complete grid outage, the critical load will always be protected. PowerExchanger can also deliver additional financial and performance benefits, thanks to peak shaving. When peak-time energy comes at a premium, PowerExchanger enables on-site UPS energy reserves to cover consumption peaks and keep costs low.

www.abb.com

Acquisition of SL Power Expands Addressable Market

Advanced Energy Industries announced that it completed the previously announced acquisition of SL Power Electronics Corporation from Steel Partners Holdings L.P. The acquisition adds complementary products to Advanced Energy's medical power offerings and extends its presence in several advanced industrial markets. "The addition of SL Power expands our offerings for industrial and medical applications," said Steve Kelley, president and CEO of Advanced Energy. "I believe SL Power's strong customer base, complementary product portfolio, and highly skilled team make it an ideal fit for Advanced Energy." The acquisition of SL Power Electronics is expected to be accretive to 2022 earnings on a non-GAAP basis and to generate over $4 million of annualized cost synergies. Management intends to provide more detail on the forward-looking benefits of this acquisition when it announces the first quarter financial results.

Advanced Energy

www.advancedenergy.com

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New York-based 200mm Silicon Carbide Fab

Wolfspeed opened its Mohawk Valley Silicon Carbide fabrication facility in Marcy, N.Y. with a ribbon cutting ceremony with Federal and State Officials. The 200mm wafer fab will help lead the industry-wide transition from silicon to Silicon Carbide-based semiconductors.

New York Governor Kathy Hochul was on site to officially welcome Wolfspeed to Mohawk Valley, in addition to Eric Bach, Senior Vice President of Product and Chief Engineer at Lucid Motors. As a key partner, Lucid Motors had the honor of "cutting the ribbon" with its Lucid Air®, named the 2022 MotorTrend Car of the Year®. Wolfspeed recently announced a multi-year agreement with Lucid to supply Silicon Carbide devices.

"We are honored to be joined by these government, community, and industry leaders to celebrate Wolfspeed's Mohawk Valley Fab, New York State's economic competitiveness and American chip manufacturing," said Gregg Lowe, president and CEO of Wolfspeed. "I am incredibly proud of the team, and all of our partners, who brought this monumental fab to life in such a short time. This fab will not only supply customers in 2022 but also support long-term American competitiveness."

The automated Mohawk Valley facility is the world's first and largest 200mm Silicon Carbide fab providing uncompromised wafer quality and higher yield. The devices developed in Mohawk Valley will be critical in feeding Wolfspeed's $20B+ pipeline and the global semiconductor industry. More than 600 high-tech Mohawk Valley jobs will be created by 2029.

www.wolfspeed.com

Partnership on Developing Power Devices for Power Supply Systems

ROHM and Delta Electronics have entered into a strategic partnership to develop and mass produce next-generation GaN (gallium nitride) power devices. Combining Delta's power supply device development technology with ROHM's power development and manufacturing expertise will make it possible to develop 600V breakdown voltage GaN power devices optimized for a wide range of power supply systems. ROHM has already established a mass production system for 150V GaN HEMTs featuring an 8V gate withstand voltage in March 2022. This will allow ROHM to expand its lineup of EcoGaNTM for power circuits in IoT communication and industrial equipment (i.e. base stations, data centers) while further improving device performance.

Kazuhide Ino, Managing Executive Officer, CSO, ROHM: "ROHM is extremely pleased to enter into a strategic partnership for GaN power devices with Delta. As power semiconductors – a key area of focus for ROHM – play an increasingly important role in achieving a decarbonized society, ROHM will continue to develop advanced devices in a range of fields utilizing Si, SiC, and GaN, along with solutions that combine peripheral components such as control ICs that maximize their performance. Through this partnership, ROHM will mass produce GaN power devices that can contribute to the configuration of more efficient power supply systems as well as develop GaN IPMs that integrate analog ICs (one of ROHM's strengths) at an early stage, further expanding our lineup of easy-to-use products."

www.rohm.com

Cooperation on Transforming PCB Order Processes

Würth Elektronik Circuit Board Technology and Luminovo are connecting their products to enable their customers to adapt a much simpler, faster and more accurate PCB prototype costing and quoting process. Using the Würth Elektronik API (application programming interface), Würth Elektronik's PCB online shop gets directly connected to LumiQuote, Luminovo's RfQ software. LumiQuote automatically extracts all relevant technical parameters of required PCBs using the modern PCB engine. The technical information is now sent directly to the PCB online shop via the interface and prices as well as delivery times are sent back to the users in real time.

"This is a crucial value-add for users, as they can continue their quoting and ordering process without interruptions", explains Thomas Beck, managing director of Würth Elektronik Circuit Board Technology.

"At Luminovo, we are rethinking the electronics value chain. The partnership with Würth Elektronik enables us to finally bring PCB procurement into the age of automated and connected processes", states Sebastian Schaal, founder of Luminovo. He adds, "In LumiQuote, our customers not only receive a price directly, but a plausibility check also tells them immediately whether or not the requested specifications are supported by Würth Elektronik". Luminovo is working on a software suite that aims to transform processes within and between the different companies in the electronics value chain in a modern way. In addition to Stackrate, Luminovo's software solution for PCB manufacturers, LumiQuote focuses on connecting, digitising and automating quoting and procurement processes for EMS, including material and manufacturing calculations.

www.we-online.com

Fuji Electric

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www.fujielectric-europe.com

www.americas.fujielectric.com/us-semiconductors

Three Billion Motor Driver Integrated Circuits Shipped

Allegro MicroSystems announced that it has shipped its three billionth motor driver integrated circuit (IC), underpinning the strength of its motion control business. The company's motor drivers have helped customers around the world innovate safer, more robust motor-drive solutions with increased reliability. They can be found across automotive, industrial, and consumer applications in products ranging from electric vehicles to data center servers to cordless power tools.

"We add value by helping our customers improve time to market and reduce development cycles; we win when they win, and that motivates us to continue developing new motor driver products," says Steve Lutz, Business Line Director for Motors (Automotive) at Allegro. "We continue to innovate with new products that reduce energy consumption, improve battery life, and minimize carbon footprints."

The Allegro team has increased investments in motor driver R&D in recent years, yielding further advancements in its deep portfolio of embedded motion control IP. Introduced in 2019, the company's QuietMotionTM motor drivers include first-to-market field-oriented control (FOC) brushless DC (BLDC) electric motor controllers that are customer code-free. These devices are designed to provide reliable and efficient low-audible-noise performance while reducing design cycle times via simple parameter settings, which users can access using intuitive graphical user interfaces.

"Many of our customers—especially ones in emerging growth markets—lack software development resources specifically for motor drivers, and often rely on freelancers and contractor programmers," says Andy Wang, Product Line Director for Motors (Industrial) at Allegro. "We're helping those customers significantly reduce development overhead by embedding code directly into the IC, which helps them get to market faster."

www.allegromicro.com

Facility in Switzerland Houses High-tech R&D and Product Development

Power Integrations opened its newly constructed facility in Biel, Switzerland at a ceremony hosted by the company's CEO, Balu Balakrishnan, and attended by Biel mayor Erich Fehr. The 4,600-square-meter, $20 million facility is the new home for about 60 engineers and other technology professionals, a number that is expected to rise as the company continues to grow in the years ahead. In addition to modern office and laboratory space, the contemporary building houses a surface-mounted-technology (SMT) line used to develop prototypes for the company's gate-driver products. The facility also features a 25-kilowatt rooftop solar array. Power Integrations' presence

in Switzerland dates to its 2012 acquisition of CT-Concept Technologie AG. Its Biel operation specializes in gate drivers for high-power applications such as solar and wind energy, electric locomotives and efficient DC transmission lines, and is an integral part of the company's efforts in the electric-vehicle market.

Commented Mr. Balakrishnan: "We are delighted to open our new, permanent home in Biel, bringing all of our local employees under one roof and giving us ample room for the growth we expect in the years ahead. Our presence here is an essential part of our company's efforts to develop innovative products for a low-carbon future. We are grateful to the city's leaders for their support of this project, and we look forward to a long and productive future together."

www.power.com

Positive Outlook for the SPS 2022

With almost 700 exhibitors registered by the early booking deadline, the booking figures for the SPS 2022 are extremely positive. This is testament to the high level of interest in attending the exhibition for electric automation technology, which will take place in Nuremberg from 08 - 10 November 2022.

In addition to the three-day event in Nuremberg, this year's automation exhibition concept also includes an online component. "The in-person event will certainly be the main focus of the SPS 2022. However, the last two years have shown the value of digital offerings both in the run-up and follow-up to an exhibition: to give a general overview of the industry, for initial discussions, for arranging appointments on site, sharing knowledge, or even finding out about current industry topics," summarizes Martin Roschkowski, President of Mesago Messe Frankfurt. The organizer thus wants to leverage the advantages of both the real and digital worlds to offer participants the best possible exhibition experience. It also means

that those who may not be able or allowed to travel also have an opportunity to connect and interact with the SPS community online.

https://sps.mesago.com

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Global High Service Distributor of the Year

Mouser Electronics has been named the 2021 Global High Service Distributor by onsemi. This is the third year that Mouser has received this award. onsemi cited Mouser's high service distribution sales growth, market share growth, and high scores on overall process excellence.

"The support of our worldwide distribution partners is essential to the success of our company as we continue to increase revenue, profit margins and market penetration," said Jeff Thomson, Senior Vice President of Global Channel Sales for onsemi. "Mouser grew product sales, generated significant new business, and effectively supported customer needs while demonstrating our company initiative of operational excellence. We thank them for their contributions in 2021."

"We are honored to receive this recognition from onsemi, one of our valued partners and a leader in the industry," said Kristin Schuetter, Mouser Electronics' Vice President of Supplier Management, Semiconductors. "Mouser works to provide exceptional service to customers as well as our manufacturer partners, and it is gratifying to be acknowledged for our efforts."

Mouser offers onsemi's broad portfolio of energy-efficient power management, analog, sensors, logic, timing, connectivity, discrete, system-on-chip (SoC), and custom devices to help customers efficiently solve their design challenges in automotive, communications, computing, consumer, industrial, medical, aerospace, and defense applications.

www.mouser.com

Enhancing Its Digital Training Offerings Through Acquisition

Rohde & Schwarz announces that it has acquired UK-based 'The Technology Academy', provider of online training courses in the fields of RF, wireless and microwave engineering technology. The Technology Academy is an ideal partner to expand the existing training offerings of Rohde & Schwarz and will play a significant role in increasing the company's future professional services.

The Rohde & Schwarz Technology Academy combines the expertise and industry insights of the trusted T&M manufacturer – currently providing live and virtual trainings from their in-house training center as well as on-site trainings for existing customers – with the web training expertise of The Technology Academy. A holistic portfolio of on-demand courses is available 24/7 to technology professionals with different experience levels. They will have easy, immediate access to a range of certified trainings, which offer in-depth expert knowledge and industry insights. Content is delivered in a practical and application-oriented way, with a focus on clear explanations. Certificates are available for completed courses.

The Technology Academy
A Rohde & Schwarz Company

The main objective of the training offerings is to support technical staff in managing new challenges as well as staying up-to-date with the latest technologies. The web-based training format also allows both flexible and scalable learning paths. This combination of high-quality training with insights from industry experts and simple access makes it easy for companies to find the right training options for staff while simultaneously addressing time and budget constraints.

www.rohde-schwarz.com

Memorandum of Understanding to Cooperate in the Field of SiC Power Module Technology

Siemens Mobility and Mitsubishi Electric Europe B.V. have signed a Memorandum of Understanding (MoU) to cooperate in the field of SiC power module technology with the aim of enabling efficient and sustainable transportation and electrical energy savings in the transportation sector.

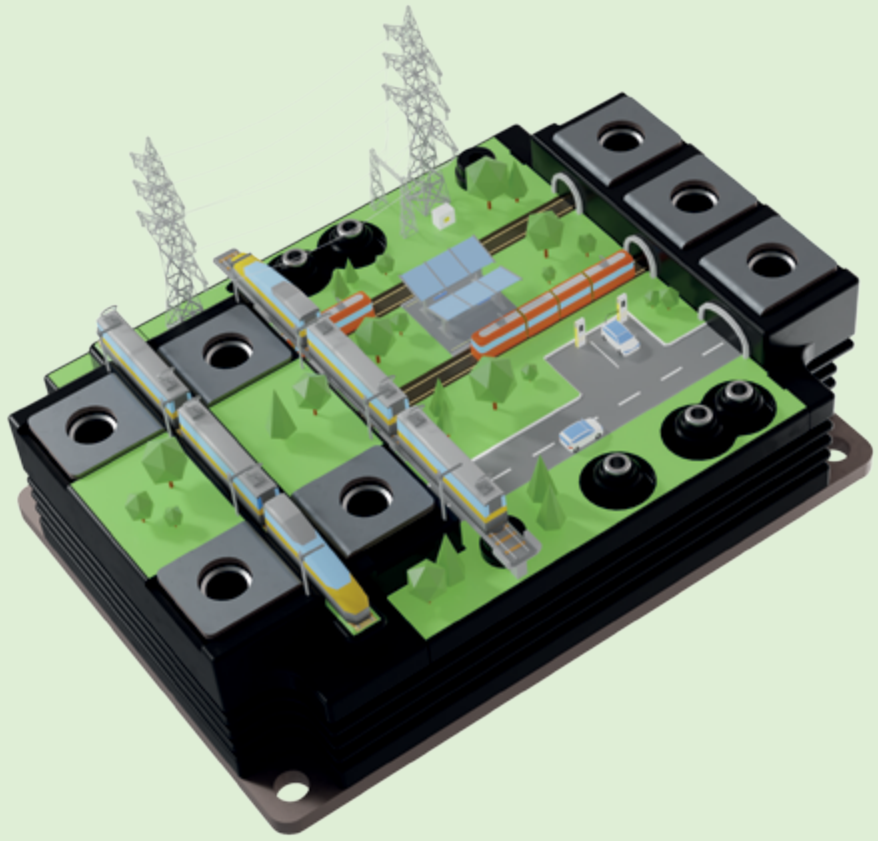
With creation of the "European Green Deal", the EU has committed itself to being the first continent to achieve climate neutrality by 2050, meaning no net emissions of greenhouse gases by 2050. At an intermediate stage, emissions are already to be reduced by 55 % by 2030 compared with 1990. The European Green Deal will result in binding directives for individual sectors regarding CO2 emissions.

Mitsubishi Electric's SiC devices have proven long-term reliability in the most demanding of applications such as traction inverters in trains. The potential for energy savings through the use of Mitsubishi Electric's wide range of SiC power devices in railway technology exists particularly in the area of traction drives. In particular the full SiC 3300 V power modules contribute to energy saving and the downsizing of traction inverters.

Siemens has always been a pioneer in the construction of electrically powered trains. Their 140 years of experience forms the basis for the new Mireo Plus regional train platform, which enables operators to run their operations efficiently and economically without local CO2 emissions. Using the innovative technology of the battery powered Mireo Plus, Siemens Mobility enables electrification of railway lines even without a continuous overhead contact line.

www.mitsubishichips.eu

AUTOMOTIVE HOME APPLIANCES INDUSTRIAL POWER TRANSMISSION RENEWABLES RAILWAY



YOU CAN BUILD ON IT.

OUR POWER MODULES – YOUR GREEN DEAL.

Now on YouTube: High voltage SiC power modules for highest reliability railway applications

LV100 High Voltage Power Modules

// Standardised dual packages with 6 kV and 10.2 kV insulation voltage
// IGBT chips with latest generation CSTBT™ technology and RFC diodes
// Robust main terminals suitable for doubling the rated module current in case of using SiC-chips
// High power density and low thermal resistance by new MCB (Metal Casting direct Bonding) technology
// High robustness/resistance against environmental influences due to the newly developed SCC (Surface Charge Control) process

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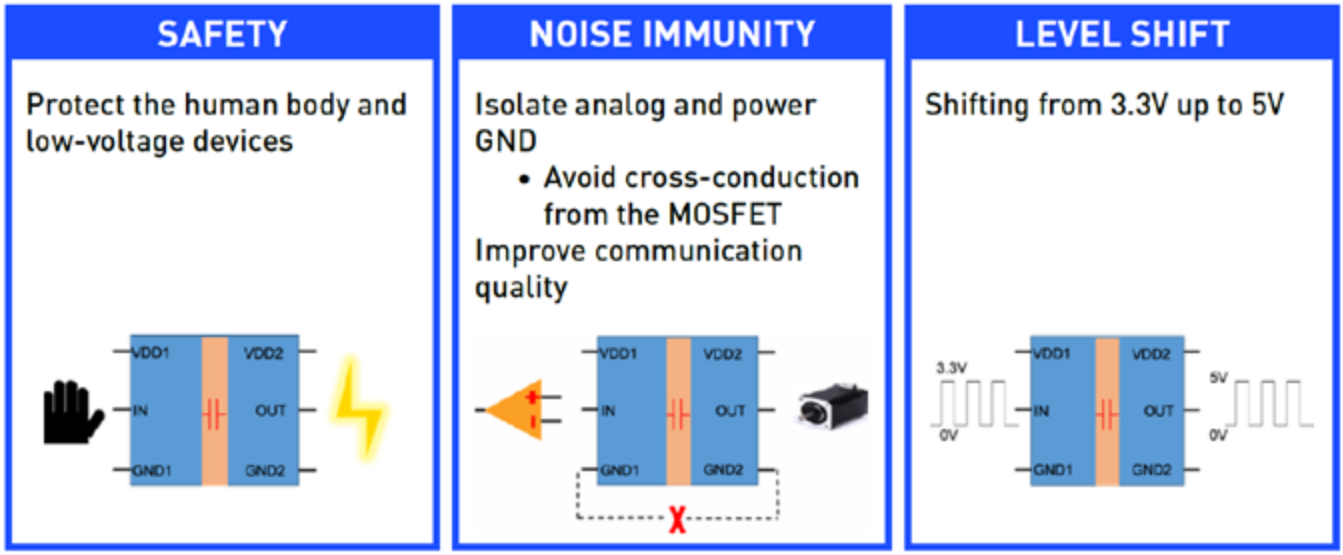


MPS offers a suite of robust isolated solutions designed to meet stringent high-power requirements. These solutions include isolated gate drivers, isolated current sensors, isolated power modules, and digital isolators with optional integrated power. Isolation has become a critical safety component to protect both the human body and sensitive low-voltage devices in high-power applications such as solar inverters, DC fast-charging stations, energy storage, servers, and electrification in automotive. MPS's robust isolated products use capacitive isolation to provide high CMTI while minimizing supply current. Noise immunity is achieved by isolating the analog and power ground signals to avoid cross-conduction from the MOSFET and improve communication quality. Higher source and sink peak currents than similar solutions enable high efficiency and industry-leading performance.

Monolithic Power Systems will be exhibiting at Embedded World 2022 and will showcase its technologies both on the expo floor and virtually, including high-power isolated solutions, battery management solutions, motor control and sensor solutions, and digital power solutions for computing.

In addition, MPS will be highlighting their motion control capabilities. The MP6570 motor driver solution is easy to use, and includes an embedded field-oriented control (FOC) algorithm with flexible parameter configurations. It is highly versatile, supporting speed, position, and torque modes, and it offers flexibility with selectable SPI, I2C, and RS-485 interfaces. The MP6539 offers a 100V operating voltage to support a wide range of applications, an internal current-sense amplifier that minimizes component count and reduces BOM cost, as well as extensive protection features to enhance system reliability.

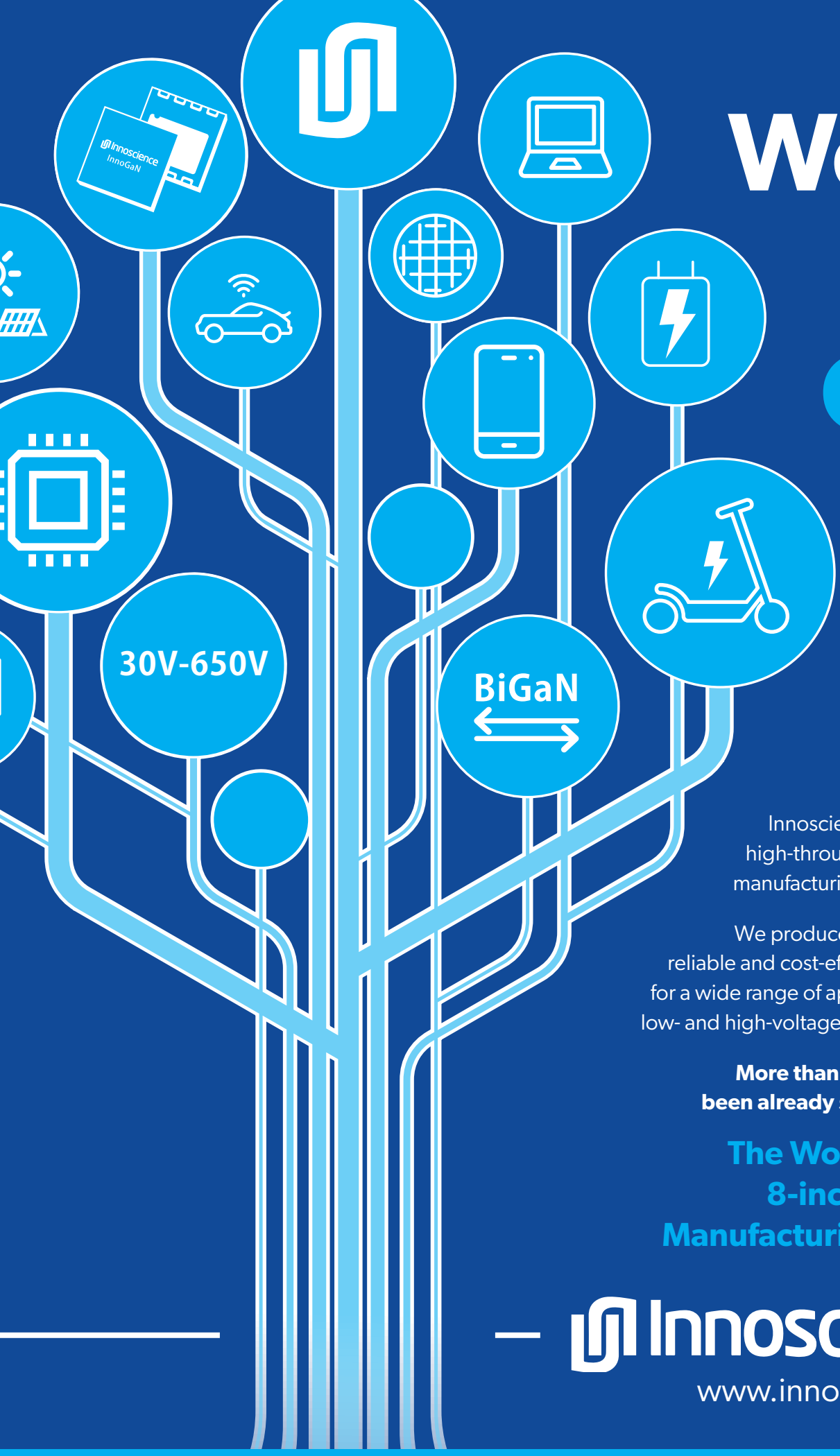
MPS's battery management products offer a high level of integration and configurability, which reduces design time, solution size, and complexity. Features include:

- Fast charging: Unique integrated power FET process that allows for faster charging and cooler operation
- High accuracy: State-of-charge (SoC) estimation, input current limit, charge current, and battery voltage regulation
- Safety focused: JEITA NTC monitoring, charge and watchdog timers, thermal regulation, as well as under-voltage (UV), over-voltage (OV), and over-current (OC) protections
- Quick time-to-market: Programmable settings allow for easy customization and short design time

The MPS MagAlpha family of magnetic angle position sensors offers a way to measure angles. The MagAlpha range also offers performance advantages compared to rival magnetic sensing technologies. MagAlpha sensors use the patented SpinAxisTM Hall measurement technique, which provides instantaneous angle position in a digital format. It uses a phase detection approach that eliminates any need for analog-to-digital conversion or complex angle calculation used by more traditional technologies.

To learn more about our compact, efficient technologies and new products, visit MonolithicPower.com and stop by to see MPS on the Embedded World expo floor: 3A-310

www.monolithicpower.com



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SiC MOSFET Power Modules for Automotive Application

To address the automotive industry Leapers Semiconductor, a developer and manufacturer of SiC power modules, introduced its HPD series SiC power modules (figure 1) designed specifically for the electric vehicles.

HPD series are 1200 V three-phase water-cooled SiC MOSFET power modules in industry recognized automotive footprint, which are optimized for traction inverters and motor drives. To deliver automotive grade HPD SiC power modules Leapers Semiconductor use its patented Arcbonding™ technology (figure 2).

Unlike traditional Al wire bonding technology used by many manufacturers of automotive grade power semiconductors, Arcbonding™ patented chip surface connecting technology ensures the reliability of SiC modules reach automotive application requirements, while significantly reducing parasitic resistance and parasitic inductance. Besides, Arcbonding™ proved to significantly reduce static losses, improve power cycling, and the ability of short time impulse current.

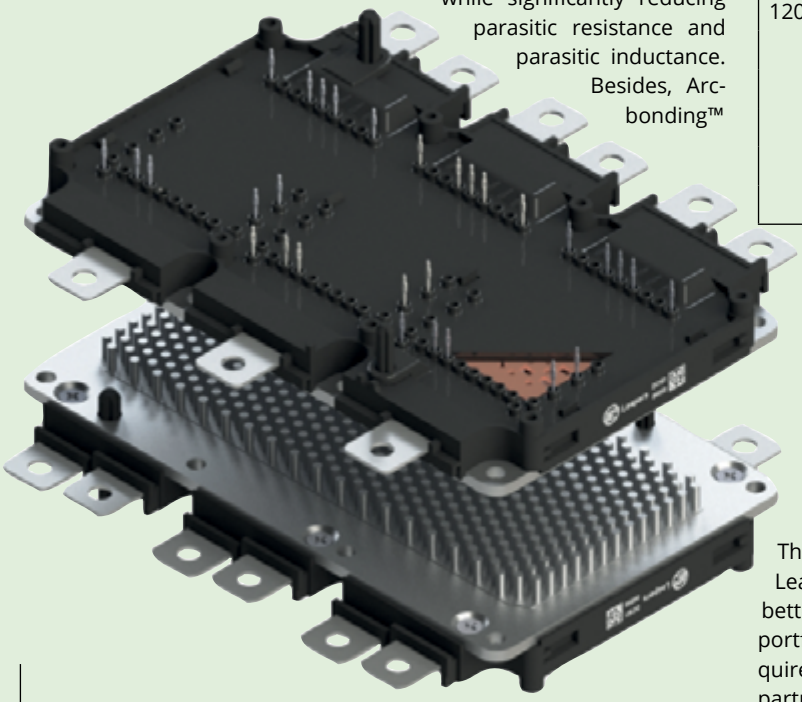

Figure 1: HPD Series SiC Power Modules

In HPD series Leapers Semiconductor uses silver sintering for die attach, high grade Si3N4 AMB substrates for higher thermal performance and robustness, and highly reliable epoxy resin potting technology. All this leads to:

- optimized internal low stray inductance and Arcbonding™ structure, significantly improved dynamic switching performance;
- 20-30% higher power density than modules from major competitors;
- lower thermal resistance.

Voltage (V)	Part Number	Current (A)	Rdson (mΩ)
1200	DFS04FB12HDW1	400	4.25
	DFS03FB12HDW1	600	2.8
	DFS02FB12HDW1	800	2.1
	DFS04FB12HDB1	400	3.35
	DFS03FB12HDB1	600	2.2
	DFS02FB12HDB1	800	1.7

Leapers Semiconductor's HPD series SiC power modules deliver performance for xEV application. Thus, design engineers can expect to:

- have high power density for reduction of system size;
- provide increased power efficiency;
- increase battery utilization efficiency.

Leapers Semiconductor offers HPD series modules in Full Bridge topology which cover power requirements of 150kW to 400kW.

Through its technological innovations for automotive industry Leapers Semiconductor aims to move humanity forward to the better and greener future. Leapers Semiconductor's SiC product portfolio including HPD series power modules responds to all requirements set by the xEV manufacturers, and together with its partners Leapers Semiconductor will contribute to reach the target set to face the global challenges, especially driving modern society to carbon free future.

www.leapers-power.com

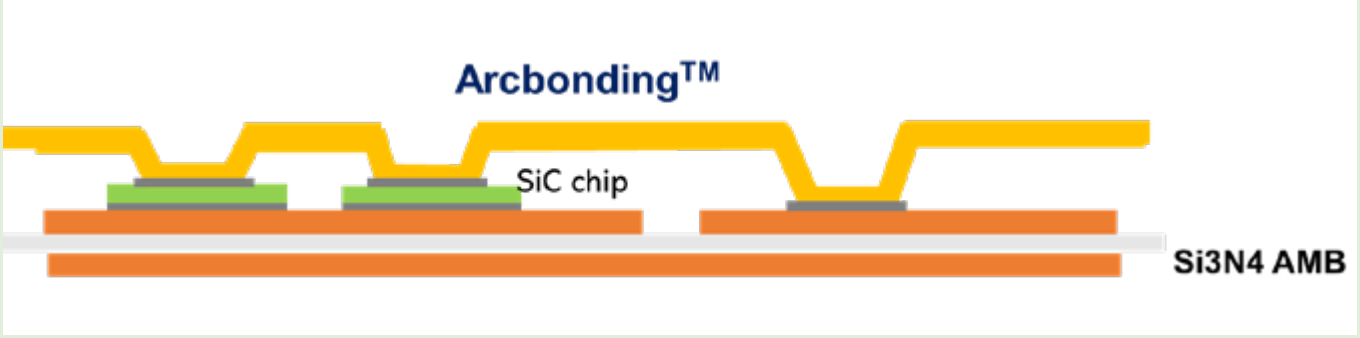

Figure 2: Leapers Semiconductor's Patented ArcbondingTM Technology

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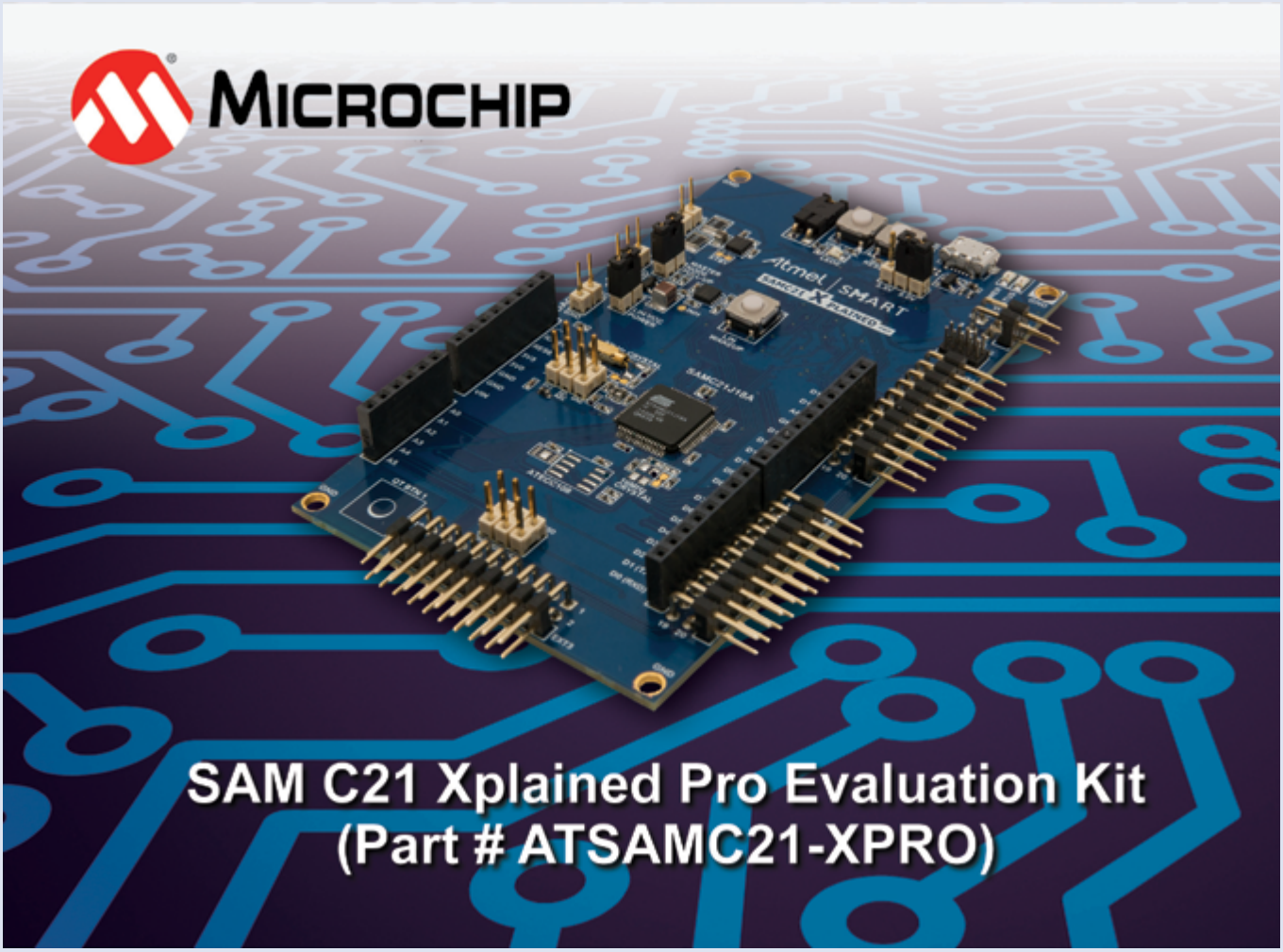

The SAM C21 Xplained Pro evaluation kit is a hardware platform for evaluating the ATSAMC21J18A microcontroller (MCU). Supported by the Studio integrated development platform, the kit provides easy access to the features of the ATSAMC21J18A and explains how to integrate the device into a custom design.

Including an on-board Embedded Debugger, the Xplained Pro MCU series evaluation eliminates the need for external tools to program or debug the ATSAMC21J18A. The kits offer additional peripherals to extend the features of the board and ease the development of custom designs.

The Microchip SAM C series of 5V Cortex M0+ devices is designed for industrial and commercial applications in noisy environments. These products feature robust communications peripherals including the SERCOM module and CAN FD, along with advanced motor control peripherals, and the Peripheral Touch Control (PTC) for developing robust user interfaces.

For your chance to win a Microchip SAM C21 Xplained Pro Evaluation Kit or receiving 15% off your next Microchip purchase and Free Shipping, visit https://page.microchip.com/Bodo-SAMC21.html and enter your details in the online entry form.

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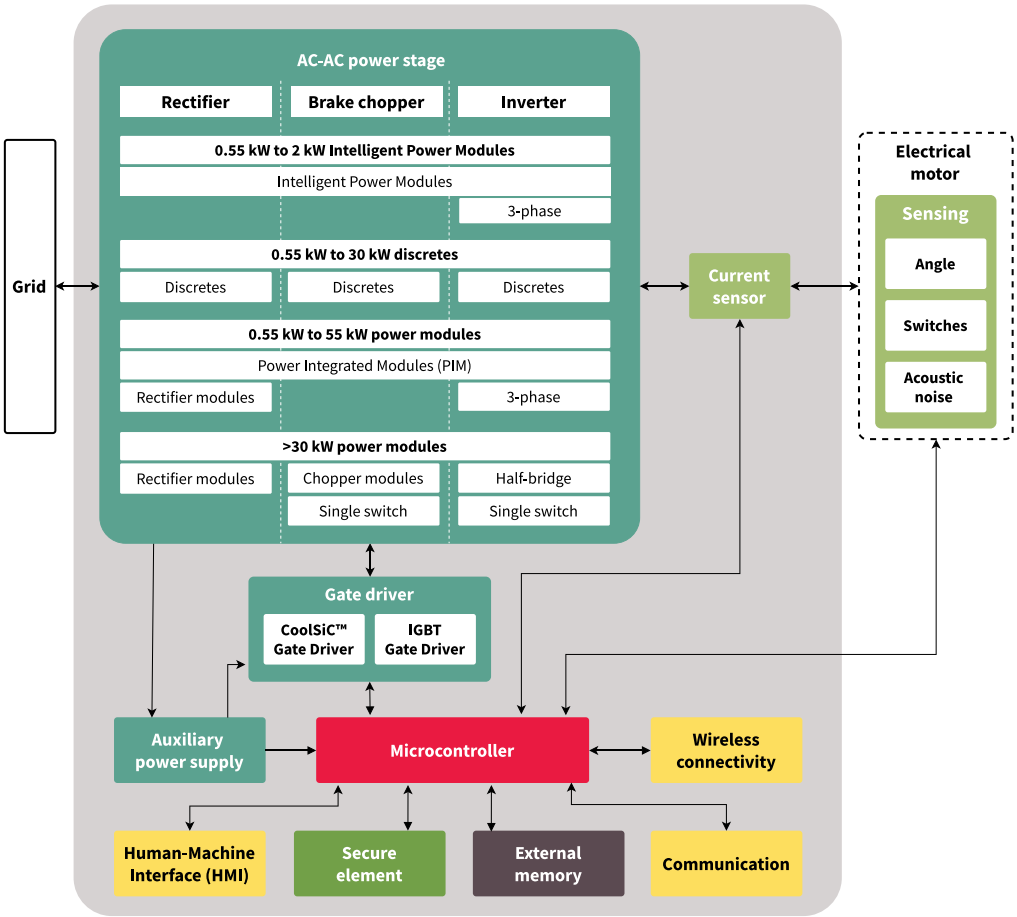

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On a Power Journey

Young and ambitious – how Nexperia delivers on its aspiring plans for growth

Just five years ago, European headquartered Nexperia entered the semiconductor market as an independent entity. The former Standard Products division of NXP started out with an annual revenue of about $1.1 billion. Today, this number has already exceeded the $2.1 billion mark. By 2030 Nexperia plans to reach $10 billion in revenue. I had the chance to interview Toni Versluijs, General Manager Business Group MOS Discretes, and Mark Roeloffzen, General Manager Business Group Bipolar Discretes.

By Bodo Arlt, Publishing Editor, Bodo's Power Systems

Bodo: Even though Nexperia is a fairly young company, it demonstrates remarkable growth. What is the recipe for the success we have seen lately?

Mark Roeloffzen: Yes, our development since inception has been truly extraordinary. Definitely, one reason for this is that we were able to build upon a solid foundation with a strong track record in semiconductor manufacturing over several decades. Another major aspect is the fact, that right from the beginning our leadership has been committed to a continuous global investment strategy – in research and development, production capacities and above all, people. At the end of the day, it sounds simple, but I would say this: TeamNexperia managed to deliver on innovative products that our customers need.

And it is this TeamNexperia that enabled us to become a leading expert in the high-volume production of essential semiconductors. With our 15,000 product-strong portfolio we serve virtually every electronic design in the world. In 2021 our employees across the globe added more than 800 new products to the line, all while also shipping more than 100 billion units in 2021. Our customers appreciate that we consistently deliver on reliability and efficiency. As a result, we made a name for ourselves relatively quickly and recently saw a 49 percent year-on-year increase in our total revenue, massively outperforming the overall semiconductor market which grew by 30% in 2021.

Mark Roeloffzen

Bodo: What are some examples of recent investments?

Toni Versluijs: Our focus is always to keep up with the needs of our customers. Last year we saw record CAPEX spending in Europe and Asia, tripling the outlay from the previous year. Key examples include further expanding production capacities in our European wafer fabs, as well as the acquisition of a semiconductor production facility in Wales – Nexperia Newport. This new facility, where we continue to invest in equipment and people, complements our strong European manufacturing operation.

And most recently, we are about to launch a new design center in Dallas, Texas. This is the first research and development facility we have in North America. The growing team here will focus on the development of analog signal conversion and power management ICs. This represents an important company milestone for Nexperia.

Bodo: In what sense?

Toni Versluijs: Well, it is quite simple, when you take the megatrends of the semiconductor industry into account. Connectivity and digitalization, electrification, industry 4.0 and automation, sustainability, and energy efficiency open considerable opportunities in terms of power management and signal conversion. For example, each electric vehicle requires four to six times more semiconductors than a conventional car. It is also predicted that by 2030, 80% of the global population will be connected via 5 and 6G technology, the mobile segment will grow as the demand for smartphones further increases.

Toni Versluijs

We want to capture these opportunities by strengthening and expanding our portfolio with more complex and high-power products. This means, we are transitioning from commodity towards more differentiated and unique products.

Bodo: Does that mean you are changing your company strategy entirely?

Mark Roeloffzen: Not really. This is all part of our long-term strategy which will enable us to transition into a world leader of essential semiconductors with a revenue of more than $10 billion by 2030. The strength of our brand has been built on our existing portfolio of essential semiconductors like logic, discretes and power MOSFETs.

In 2021 we have established two new business groups: IGBTs & Modules, and Power & Signal Conversion. These two new business groups, in combination with the existing business groups, target to further expand our offering in the power discrete domain: like SiC, GaN, MOSFETs, IGBTs, Power Modules, Analog ICs and System-In-Package solutions. This extended range will enable us to better serve our customer and market requirements in the severe growing power domain. Next to the impact made on a power efficient world, the focus on profitable growth by innovation, will help us to become the number one in the segments we operate in.

Bodo: That sounds like an ambitious plan for the portfolio. How do you intend to make that happen?

Toni Versluijs: That is correct, reaching that goal means a significant shift within our portfolio. If we look back at 2017 for example, differentiated and unique products made up roughly 40%. We are now striving to grow to have a much more advanced portfolio by

2030, where that portion will grow up to 85%. As part of this plan, we are working closely with our strategic customers to ensure early roadmap alignment and timely design-in, which will lead to a higher percentage of sales in innovative products.

To deliver these products in the high volumes required, we are expanding our technology, manufacturing capacity and workforce, through significant additional investments.

Bodo: Can you be more specific, please?

Mark Roeloffzen: We now have record investments in research and development. In 2022, we will increase our R&D investment by more than 50 percent when compared to 2021. The R&D spend as a percentage of our sales will continue from about 10% today towards 15% over time, helping us to differentiate ourselves in the marketplace by having an innovative portfolio which allows us to grow faster and more profitably.

Furthermore, we are investing in new production capacity, like 12 inch as well as building more strategic partnerships with external foundries and subcontractors that will play a vital role in our future growth. Compared to 2021, the investments in CAPEX will double.

And last, but not least, our people are key to our success. We need to further expand our 14,000+ strong TeamNexperia by hiring additional talent for a variety of functions, with a strong focus on development roles. Here, our strategy is to hire talented people "where they are" – by establishing and developing design centers around the globe close to known talent pools like Penang, Shanghai, Newport, and Dallas and more to come.

Bodo: As a global player, where do you see your responsibilities in terms of sustainability?

Toni Versluijs: One of the biggest challenges our generation is meeting the increasing energy demand. And while the global electricity consumption per capita has grown by 50% in the last 30 years, there seems to be no end in sight. We are still witnessing a boom in consumer technology with mobile phones, computers, laptops all requiring power for charging as well as for the supporting communication infrastructure. Moreover, there are motors of all sizes where we've never seen motors before – from recliner seats and garden tools to lifebelts.

As a power semiconductor maker, we have been placed in a position of responsibility as our products are carbon-neutral enablers. As engineers, we must deliver improvements in power conversion efficiency, which will require solutions other just than standard silicon. Here is an open window for wide bandgap semiconductors (WBG) to play an important role in taking on the challenges of the next decades.

At Nexperia, sustainability is firmly embedded in the way we do business, as we believe an efficient company creates efficient products. We as a company hold part of the key for an energy efficient future, a responsibility we take very seriously.

Bodo: Are silicon carbide (SiC) and gallium nitride (GaN) the answer to the energy challenge?

Toni Versluijs: For relatively new technologies SiC and GaN are already efficiently outperforming traditional silicon and still have a so much potential! But there is an arsenal of technology options available, and there is room for all. Each technology will have its own sweet spot which will change over time, suiting different application requirements depending on the trade-off between performance, cost, and availability.

Today, silicon is widely used through decades of evolutionary improvements. GaN will proceed similarly given all the R&D work and investment that are in progress. Power GaN has already proven its worth in many low-power applications, facilitating more compact and higher efficiency solutions. We are pushing GaN to even higher power levels, providing solutions from 2 kW all the way up to 250 kW. We have even worked with customers to demonstrate that at 650 V these power levels are achievable. For the voltage ranges above 650 V we are developing a SiC rectifiers and SiC FET portfolio. This will assure that in due time we will have a full WBG portfolio comprising GAN and SiC.

In addition, Nexperia is developing other adjacent technologies to best address the high voltage power semiconductor market such as IGBT, HV MOS or recovery rectifiers. We strongly believe that the best solution for each different customer application depends on balancing performance, cost, and supply. Thus, Nexperia will offer all technologies, so we offer a choice for every customer trade off.

Bodo: Thank you both for your time and for these insightful answers. I will keep my eyes open for more to come from Nexperia!

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CIPS 2022 - 12th International Conference on Integrated Power Electronics Systems

The International Conference on Integrated Power Electronics Systems (CIPS) focuses on the technological background, starting with the components to be integrated (such as passives and sensors), but with the largest share in the conference addressing power semiconductor chips made out of silicon (Si), or more increasingly, wide bandgap materials like silicon carbide (SiC) and gallium nitride (GaN).

By Andreas Lindemann, Otto-von-Guericke-University Magdeburg and Nando Kaminski, University of Bremen, Technical Chairs CIPS 2022

All of these components need to be packaged, where materials and processes play an important role and define the resulting circuit elements including parasitics such as stray inductances. The type of package usually determines the thermal behaviour of the components as well as their reliability. Recent results reported at the 12th CIPS in 2022 refer to various approaches of optimisation such as embedding the chips in printed circuit boards and providing double-sided cooling, which ensures a high level of reliability even under demanding operational conditions in modern applications.

The technology development trend of achieving an increase in efficiency ratings along with significant reduction in system size with higher reliability, is only possible by developing an elevated level of system integration. The ultrafast switching devices based on wide bandgap material further challenge technology barriers in terms of power density, efficiency, and operating temperature. Along with this movement we are faced with new challenges such as how to manage all the distributed parasitic capacitances and inductances. On the other hand, new interfacing materials are needed to improve the heat transfer and meet the requirements for the coefficient of thermal expansion (CTE).

Many questions related to the power electronic development trends and technology roadmapping related to higher power densities, higher efficiency ratings, improved reliability and new design rules for packaging and 3D system integration were presented and discussed during the conference.

Furthermore, there were many contributions regarding the related test methods. Whilst these are mature and standardised with respect to silicon devices and while impressive results could be reported from wide bandgap devices, ongoing research is still required to understand wear-out and failure mechanisms well enough to detect and possibly predict them, and ultimately, eliminate them to achieve even more reliable components and consequently, circuits and systems. Exemplary integrated power electronic systems were reported and electromagnetic compatibility (EMC) was addressed. The latter is critical considering the steep voltage and current slopes occurring during switching actions of power semiconductors, where a proper power electronic design may significantly help to achieve the indispensable EMC at system level. Beyond these technical aspects, the strong participation of industry in the conference ensured that cost was appropriately considered. A higher investment in power semiconductor components and their integration can lead to economic benefits at system level where power electronics enables further optimisation and new functionality.

The CIPS conference was organised by VDE-ETG in cooperation with ECPE European Center for Power Electronics. The 12th CIPS took place March 15th to 17th, 2022 as a hybrid conference with two thirds of the attendees participating in person in Berlin and highly appreciating the opportunity to finally exchange directly again. The conference proceedings including keynotes, invited and submitted papers are available from VDE-Verlag (ETG-Fachbericht 165) and in IEEE Xplore. The next CIPS is scheduled for March 12th to 14th, 2024 in Munich with the deadline to submit papers in summer 2023; current information will be provided at www.cips.eu.

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The Evolution of Application Samples

A brief history of how pre-made power electronics assemblies were created to reduce development times for utility-scale solar inverters

By Emiliano Meza, SEMIKRON Elektronik GmbH & Co. KG

The Solar Boom

While some utility-scale solar projects already existed at the turn of the 21st century, the three years leading up to 2012 saw annual solar installations increase from 58MW to 1.8GW, a 30-fold increase (Figure 1). Annual utility-scale solar installations then grew to almost 80GW during 2021 according to the International Energy Agency. Such large, decentralised energy sources pushing power to electrical grids caused increasing concerns about grid stability, as power generation became dependent on the day/night cycle as well as on weather. With electricity being an essential utility for most people, there was pressure to reduce overall costs ($/W) and the task fell upon inverter designers to simultaneously to reduce system costs and increase power at the same time.

Figure 1: Historical global solar installations by year

These requirements resulted in a number of technical trends in power converters, including:

- Decreasing filter size (while meeting new power quality requirements)
- Increased DC voltage capability (e.g. 1500V_{DC})
- Improved grid support (e.g. reactive power, Low Voltage Ride Through (LVRT) capability)
- Better integration into energy storage systems (bidirectional operation)

These technical trends were often best served by different converter topologies that were more complex to develop. SEMIKRON created power modules to address these topologies but also had to create "Application Boards" to help connect standard driver cores to gate the devices and provide insights into how error handling was done with more complicated switching patterns. Schematics, board layouts, and Technical Explanation documents were provided to the customer to give them a head start on a production design.

These Application Boards inevitably led to the development of full "Application Samples" where module, Application Board, driver, heatsink, DC link, etc. were integrated into a working power stage. These Application Samples expanded the principle of providing customers with working power circuits where critical connections (e.g. commutation loops) had already been designed and tested.

The Shift to 3-Level with MiniSKiiP 3L Application Sample

In order to maintain the quality of the electrical grid, regulations such as IEEE 519 set maximum individual harmonics to 3% and total harmonic distortion to 5%. Grid-tie filters with inductors and capacitors smooth the output currents into a sinusoidal waveform and are required to keep solar inverters under the maximum harmonic allowance. Increasing the switching frequency of the grid-tie inverter reduces the size of grid filters as well as the material costs. However, the switching frequency is limited by losses generated in the transistors during each turn-on and turn-off operation. Three-level topologies can assist with this by almost doubling the frequency of the ripple required to be filtered over 2-level converters. Given the additional costs for more chips and driver components, a balance is needed to reduce overall system costs. Figure 2 shows some typical 3-level topologies, such as:

- NPC: Neutral Point Clamp
- TNPC: T-Type Neutral Clamp
- ANPC: Active Neutral Point Clamp

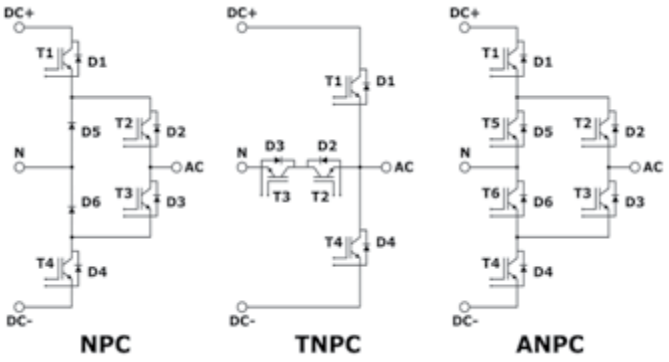

Figure 2: Typical 3-level topologies

Though many power electronics developers were experienced in 2-level voltage source inverters, such as motor drives, very few had experience with 3-level topologies. This led SEMIKRON to develop the first Application Sample, based on MiniSKiiP using NPC topology. The evaluation system supports 3-level software development while protecting the hardware, giving safety to users while developing code. A Complex Programmable Logic Device (CPLD) included in each phase leg supervises the switching sequences of the IGBTs, the dead times and the PWM sequences. The PWM signals from the control interface are routed through the CPLDs, where they are compared to a table of switching states (see Figure 3). If the PWM pattern is in the area marked green in Figure 3 (allowed switching states), the gating signals will be allowed through to the driver output stages. Destructive states, however, cause a direct connection between at least two of the three DC connections, causing current shoot-through which damages the transistors. In a potentially de-

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structive state, the outer transistor is on and the inner transistor is off, prohibiting current due to inductance to discharge and potentially damaging the transistor from overvoltage. If the PWM pattern causes a destructive or potentially destructive state, the CPLD will shut down the phase leg using the correct switch-off sequence.

T1	0	0	0	1	0	0	1	0	1	1	0	1	1	1	0	1
T2	0	1	0	1	1	0	0	0	0	0	1	1	1	0	1	1
T3	0	0	1	0	1	1	0	0	0	1	0	1	0	1	1	1
T4	0	0	0	0	0	1	0	1	1	0	1	0	1	1	1	1
state	allowed						potentially destructive					destructive				

Figure 3: Safe, destructive and potentially destructive switching patters for NPC topology

Additionally, the CPLD compares the measured analogue signals with the maximum permissible values for current, temperature and voltage. If any of these exceed the safe operating range, the CPLD shuts the phase-leg down. It then ensures the inner switches (T2, T3) of the NPC topology are on before the outer switches (T1, T4) and the outer switches are off before the inner switches. Once the phase leg is back in the safe operating area, the CPLD allows operation to resume.

Increased Power at 1500V_{DC}

In larger installations, increasing current to increase output power became prohibitive due to cable losses (I^2R) and material costs, so increasing the voltage became the goal. In order to avoid the cost and safety implications of moving to a medium-voltage class, the panel voltages were increased within the limits of the Low Voltage Directive (LVD). In the early stages of solar, the limit for what was considered "low" voltage differed between Europe (1500V_{DC}) and the USA (1000V_{DC}), but has now been harmonised at 1500V_{DC}.

SEMIKRON developed multiple Application Samples to test the benefits of various 3-level topologies to determine a realistic approach. The NPC topology, for example, allows switches to operate at half of the DC voltage, but has a long commutation path with increased stray inductance, thereby increasing the potential for voltage spikes and affecting switching behaviour. The TNPC topology, on the other hand, has a relatively short commutation path, but requires devices with higher semiconductor blocking voltage, which increases switching losses.

Thanks to its wide portfolio and flexibility, numerous Application Samples were based on SEMiX 5 power modules. While the early SEMiX 5 Applications Samples used the SKYPER 42 LJ driver core, this later served as a testing platform for the SKYPER 12 PV, developed specifically for 3-level solar operating up to 1500V_{DC} and in the range of 160kVA. Two SKYPER 12 PV driver cores could fit onto a single SEMiX 5, each able to drive two IGBTs, connected via the blue Application Sample board shown in Figure 4. The blue boards actually became a designator indicating they had not gone through the rigorous SEMIKRON qualification process. Driver cores, on the other hand, are a fully qualified catalogue product from SEMIKRON, indicated by the green colour of the PCB.

Figure 4: Single phase of SEMiX 5 3-Level Application Sample with two SKYPER 12 PV driver cores

As 1500V_{DC} utility-scale solar became dominant and inverter power was increasing, there was the need to scale up the NPC topology. SEMIKRON developed the SEMITRANS 10 Split NPC, which combined two power modules for each single phase-leg, each with a half bridge circuit and one neutral point clamp diode. Originally based on IGBT E4, the SEMITRANS 10 contains 1200V devices, providing plenty of room at 1500V_{DC} for overshoot and mitigating concern about cosmic ray failure. In order to provide a simple method for customers to adapt the SKYPER 42 LJ PV driver cores to the high power modules, SEMIKRON developed a new Application Sample capable of 1.2MW with air-cooling, as shown in Figure 5.

Figure 5: Single phase-leg of SEMITRANS 10 MLI modules with Application Board and SKYPER 42 LJ PV

3-Level Short Circuit Protection

In order to protect an inverter during a short circuit, the transistors must turn off within a specified time period, t_{psc}. During a short-circuit condition, an IGBT might see many times its nominal current rating so this abnormal current must be detected and turned off within, for example, 8 or 10µs. The Application Samples implement the short-circuit protection directly on the secondary side of the gate drive circuit, providing a faster response than waiting for the error signal to be sent across an isolation barrier, processed by a primary-side controller, and having the turn-off command sent back. Compared to 2-level, this process is more complicated in 3-level topologies, not only due to the turn off sequence, but increased NPC inductance loops or smaller voltage margins.

When a short-circuit occurs, the collector current in the IGBT increases, causing the collector emitter saturation voltage, $V_{CE,sat}$ to increase. The driver board can measure the $V_{CE,sat}$ to determine whether a short-circuit is occurring, but has to wait until the IGBT is in full on-state. In order to ensure the IGBT is fully on, the detection circuit has to wait for a pre-set "blanking time", implemented in the Application Samples.

The fast interruption of a high current inevitably means a high di/dt, leading to a high voltage spike due to stray inductances that are always present in power circuits. Slowing down the switching of the IGBT increases IGBT turn-off time (dt). This reduces di/dt and, consequently, the voltage spike across the collector and emitter of the IGBT. However, when operating with a small voltage margin, active clamping is another method used to reduce reduce voltage spikes.

Active clamping is used to limit the voltage due to stray inductance so that the transistors do not exceed their voltage rating. In practice, this can become quite complex. As shown in Figure 6, Transient Voltage Suppressor (TVS) diodes are placed between the collector and gate of the IGBTs. The TVS diodes must be selected so that their protection voltage is greater than the operating voltage of the IGBT, but lower than the maximum voltage rating. Proper device selection is challenging, owing to the stack-up of device tolerances. The voltage characteristics of the devices also tend to be temperature-dependent. The resistor (R_{clamp} in Figure 6) then limits the current charging the gate and a standard diode prevents the driver from feeding into the collector in standard operation. If

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the SKYPER 12 senses a clamping event, it disconnects the driver stage from the gate to prevent the gate charging effect of the active clamping and the driver from working against each other. While the SEMiX 5 Application Sample only contains two clamping circuits to the most critical IGBTs (T2, T3), the SEMITRANS 10 adaptor board provides enough space to add clamping circuits to all the IGBTs. The Application Engineering team spent numerous months in the lab working with the SEMiX 5 and SEMITRANS 10 Application Sample to fine-tune the active clamping circuits.

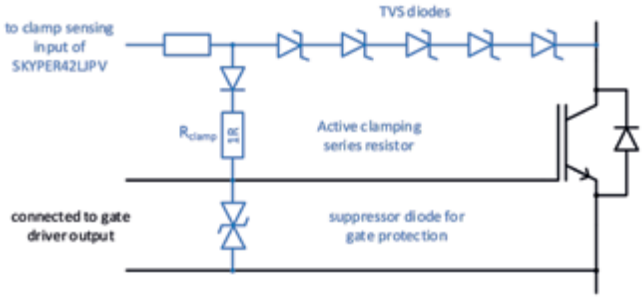

Figure 6: Active clamping circuit for SEMiX 5 Application Sample

With the increasing demand for energy storage, many of the companies developing solar inverters began adding energy storage converters to their portfolio. For the most part, the hardware for solar and energy storage was quite similar: a 3-phase inverter coupling a DC source (now batteries instead of solar panels) with an AC grid. This concept helped reproduce the solar market's economy of scale for energy storage, keeping converter costs to a minimum. However, the direction of power flow in the converter would occasionally reverse as the batteries were charging. This negative power factor (cos(phi) = -1) operation meant the diodes in the converter were subjected to a higher duty cycle. For example, in the NPC topology, D5/D6 clamping diodes became the limiting factor for maximum power during battery charging.

Thanks to chip innovations, generation 7 IGBTs offered smaller chips with the same current rating, enabling both an increase in IGBT nominal current from 1200A to 1400A and increased space that could be used for larger clamping diodes. Not only was the SEMITRANS 10 updated to include M7 IGBTs and a larger diode, the Application Sample was updated as well. The power electronics engineers at SEMIKRON France then developed a fully qualified power electronic stack, SEMIKUBE MLI, based on this Application Sample to reduce development time even further (Figure 7).

Figure 7: Three-phase, air-cooled power electronic stack based on SEMITRANS 10 capable of 1.25MW

Many countries are pushing to increase the share of renewable energy rather than traditional power plants. As this occurs, the countries are updating their grid codes to further ensure its stability, often including standards for Low Voltage Ride Through (LVRT) conditions. As energy grids around the world contain 50% to 100% of renewables, they need to continue operating during a blackout or brownout. Such conditions cause grid-tie inverters to output low voltage at a near-zero power factor. In such a situation, Active Neutral Point Clamp (ANPC) topology offers clear advantages. The additional transistors enable neutral point current to be split among more devices, reducing chip temperature and losses. [1]

In order to test this theory, the Application Sample shown in Figure 8 was developed. This Application Sample forms a single phase-leg of the ANPC topology (right side of Figure 2) capable of 1.3MW by including three SEMITRANS 20 half-bridge modules with the latest M7 IGBTs. The ANPC topology offers an optimised solution for both positive and negative power factors, eliminating the need to derate power at cos(phi) = -1. This enables faster development with SEMITRANS 20, the latest power module from SEMIKRON that features an industry standard package design for high power applications.

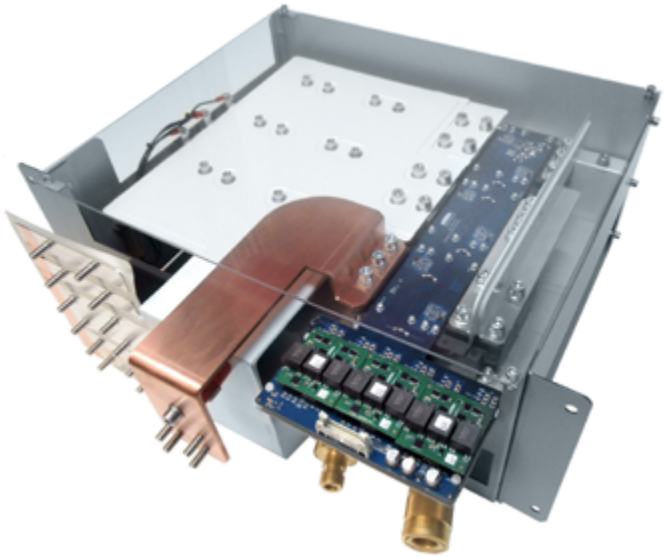

Figure 8: Single phase-leg of liquid-cooled SEMITRANS 20 ANPC Application Sample, capable of 1.3MW

Conclusion

The only constant in the solar market is change. As the solar inverter market evolves, so will SEMIKRON Application Samples. The main purpose is supporting customer development with internal development as an added benefit. SEMIKRON continues to develop new Application Samples each year, providing a starting point for customers and reducing their development times. Rather than simply manufacturing and selling hardware, SEMIKRON gives customers the design files to enable design flexibility and speed. A global network of application engineers also support customers who wish to adapt Application Samples to their needs, making SEMIKRON the ultimate partner in power electronics.

References

[1] A. Giessman, C. Schmidt and M. Spang, "The Simultaneous Use of Two Alternative Neutral Point Current Paths in a 3-Level ANPC Topology – Benefits and Challenges in High Power Applications," PCIM Asia, 2021.

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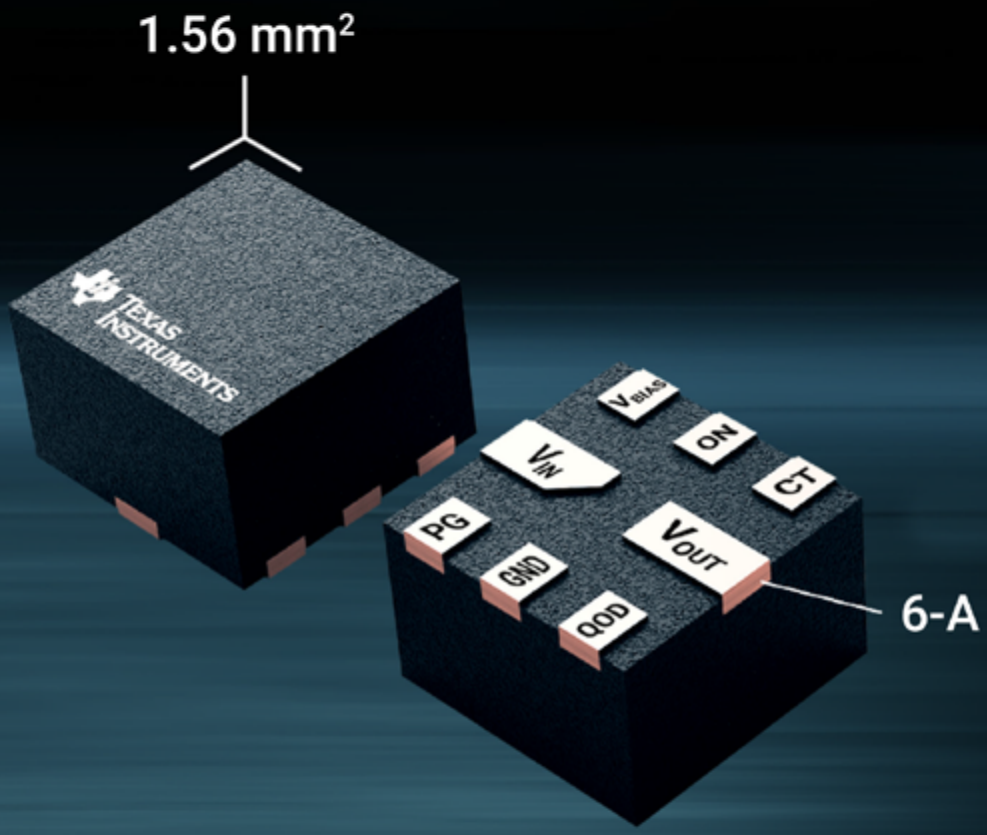

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TEXAS INSTRUMENTS

Benefits of Modular Approach in Medium Power Automotive Applications

Inside automotive applications, especially for on board converters, dimension and weight are two fundamental parameters. Lighter, smaller and efficient applications as well as semiconductors and packages are crucial. For this reason, STMicroelectronics developed the ACEPACK SMIT, a top side cooling SMT package that houses the latest and efficient SiC, Super Junction and Si IGBT technologies. The aim of this article is to show the benefits deriving from the adoption of modular approach based on ACEPACK SMIT respect to the traditional trough-hole discrete one.

By Domenico Nardo, Christian Schweizer, and Manuel Gaertner, STMicroelectronics

ACEPACK SMIT allows designer to increase the power density, increase the power efficiency, reducing the power loop, reducing the switching energies and working with a cold temperature.

ACEPACK SMIT Overview

ACEPACK SMIT is one of the latest top side cooling SMT packages with automotive grade qualification, AEC-Q101, from STMicroelectronics. It is available for several technologies: diodes, thyristors, SiC MOSFETs (650V and 1200V), Si Super Junction MOSFET and IGBT.

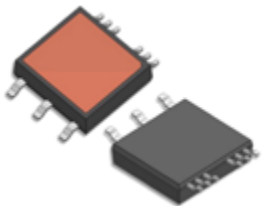

Figure 1: ACEPACK SMIT

Regarding active devices, ACEPACK SMIT enables very fast switching thanks to the kelvin pin that provides a low noise returning path for the gate signals.

Different topologies and configuration can be obtained with ACEPACK SMIT: Full bridge diodes, half bridge thyristors, boost PFC, half bridge and source to source.

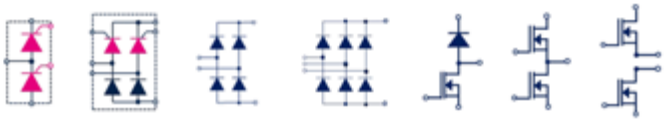

Figure 2: Possible configurations inside ACEPACK SMIT

Thanks to the DBC, direct bonded copper substrate and extended creepage it achieves a 4kV isolation. The total footprint area is 33.20x25.20 mm^2 that enables a compact design and cost-effective solution.

Test vehicle overview

For our analysis ACEPACK SMIT with two MOSFETS in half bridge configuration is chosen and we use it inside an 1500W resonant LLC half bridge. The same silicon MOSFET is used for both ACEPACK SMIT, SH68N65DM6AG, and TO-247, STWA68N65DM6AG, solutions and it is a 650V 39mΩ MOSFET. Figures 3 and 4 show the power loop respectively for ACEPACK SMIT and for TO-247.

The ACEPACK SMIT solution allows to reduce the length of power loop about 25% respect traditional TO-247 layout, indeed the total power loop Length is:

77.91mm for ACEPACK SMIT
103.63mm for TO-247

Reducing the power loop length also the stray inductance will be reduced, therefore, the overvoltage and the ringing during the turn-off are both mitigated.

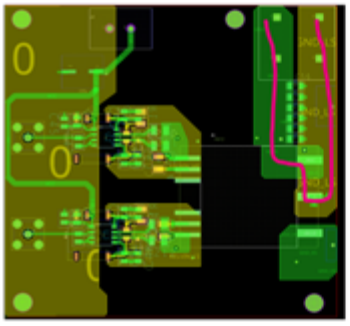

Figure 3: Layout and power loop (purple) for ACEPACK SMIT solution

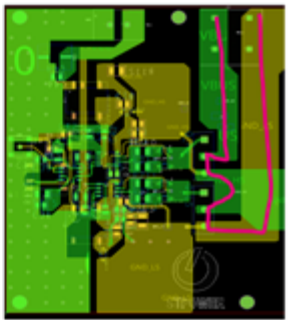

Figure 4: Layout and power loop (purple) for TO-247 solution

The test vehicle used in these tests, is a 1500W, 400V – 48V, half bridge LLC, with a resonance frequency of 125 kHz on the secondary side a center tap transformer with STPS61170C-Y, AG qualified diodes, are used.

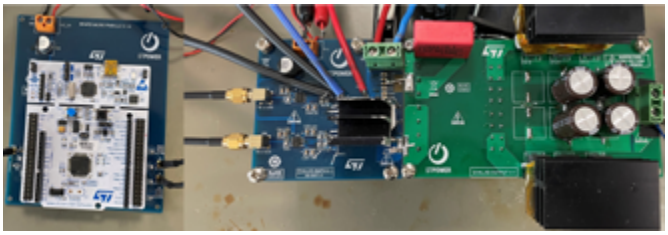

Figure 5: Test vehicle

Figure 6 shows the mounting of the ACEPACK SMIT and heatsink on the PCB. From thermal characterization also the $R_{THj-amb}$, for this solution, was measured and the value is 12 °C/W.

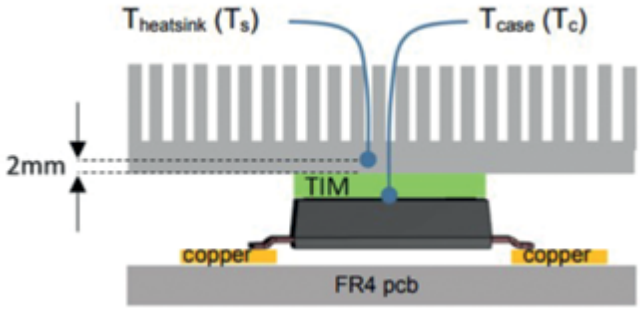

Figure 6: ACEPACK SMIT and heatsink mounting details

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For both module and discrete in this analysis the same external gate resistance are used, 22 Ω for the turn-on and 10Ω for the turn-off.

Applicative results

The first analysis regards switching energies during turn-off and the overvoltage.

In resonant applications, the E_{OFF} includes the energy stored in the C_{OSS} (E_{OSS} not thermally dissipated) and energy lost[1]. To account this, Equation 1 is modified to include the contribution of E_{OSS} and therefore derive the equation 2. Thus, the E*off represent the thermally dissipated energy that contribute to the switching losses [1].

Eq. 1

$$P_{off} = f_{sw} \cdot E_{off}$$

Eq. 2

$$P^*_{off} = f_{sw} \cdot \left(E_{off} - E_{OSS}\right) = f_{sw} \cdot E^*_{off}$$

The ACEPACK SMIT has in the entire range lower E*off, a lower value of both stray capacitance and stray inductance, respect trough-hole, allows to achieve a faster commutation, thus, reducing the switching losses.

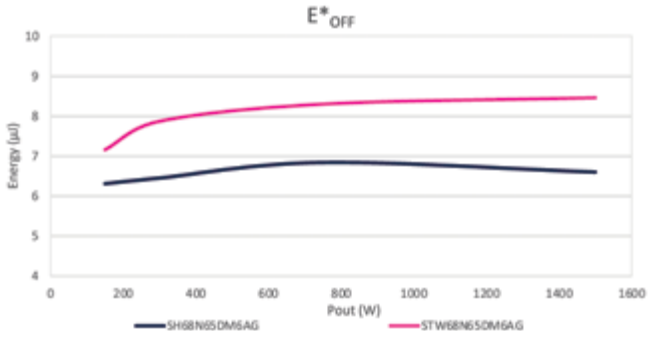

*Figure 7: E*off*

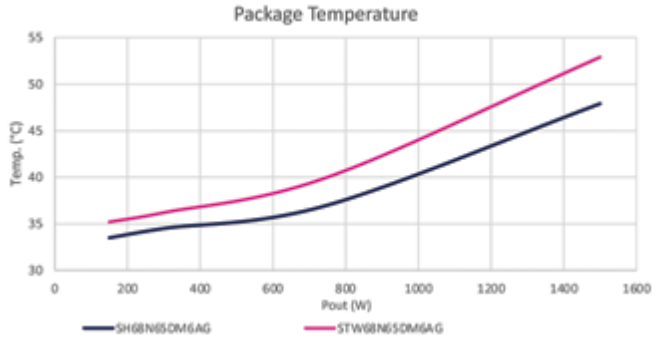

Figure 8: Case temperature

In resonant converters, that typically works with higher switching frequencies respect to hard switching converters, even a small reduction of the switching energy allows to reduce the working temperature of device and increase power efficiency. Moreover, also the smaller turn-off overvoltage contributes to reduce the switching losses. Table 1 reports the overvoltage during turn-off at different level of power. The ACEPACK SMIT helps to reduce about 8% the overvoltage.

V_{DS} turn-off peak		
Pout (W)	SH68N65DM6 (V)	STW68N65DM6 (V)
150	420	455
300	421.1	456.8
750	422.4	459.2
1500	419.2	456.5

Table 1: Turn-off overvoltage during turn-off

Figures 9 and 10, show the main waveforms at maximum load, 1500W, respectively for ACEPACK SMIT and TO-247 solution.

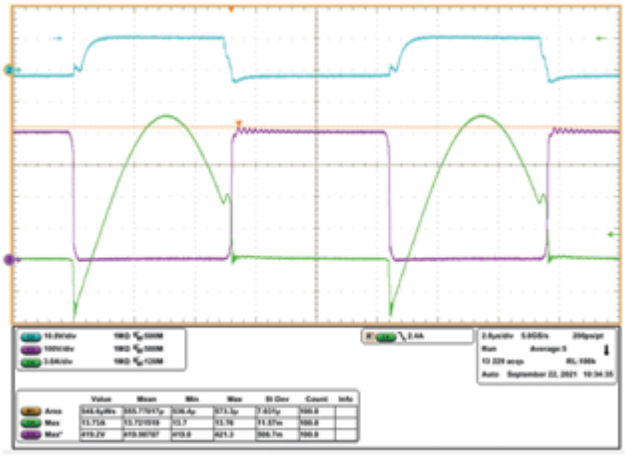

Figure 9: ACEPACK SMIT waveforms at 1500W. Light blue V_{GS}, Purple V_{DS}, Green I_{DS}

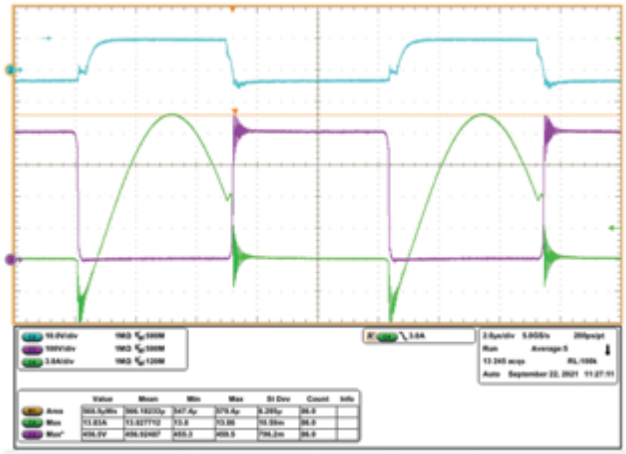

Figure 10: TO-247 waveforms at 1500W. Light blue V_{GS}, Purple V_{DS}, Green I_{DS}

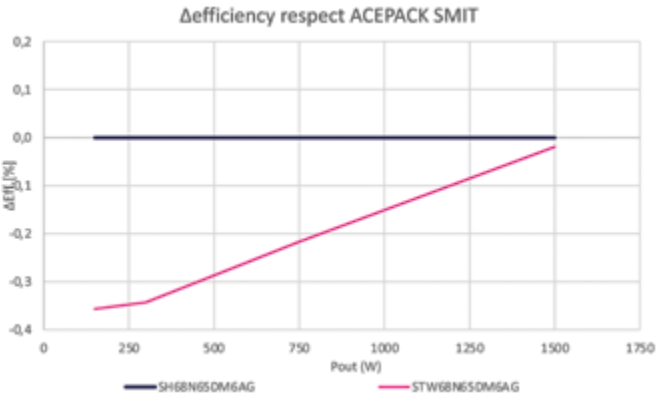

Figure 11: Delta efficiency between ACEPACK SMIT and TO-247 solutions

The lower device losses of ACEPACK SMIT, considering two devices, HB configuration, help to increase the power efficiency, but also to lower the working temperatures. At maximum load, the modular solution is five degrees coolest respect to discrete approach, as showed in figure 13.

Conclusion

In this article were compared SH68N65DM6AG and STW68N65DM6AG, same silicon but housed in two different packages respectively ACEPACK SMIT and TO-247.

Using as test vehicle a 1.5kW HB LLC. Both devices were measured at the same electrical steady-state conditions: switching frequency, dead-time, power out.

In terms of power efficiency using ACEPACK SMIT solution helps to improve it, especially at light load, indeed, SH68N65DM6AG has 0.3% better efficiency respect to the discrete solution.

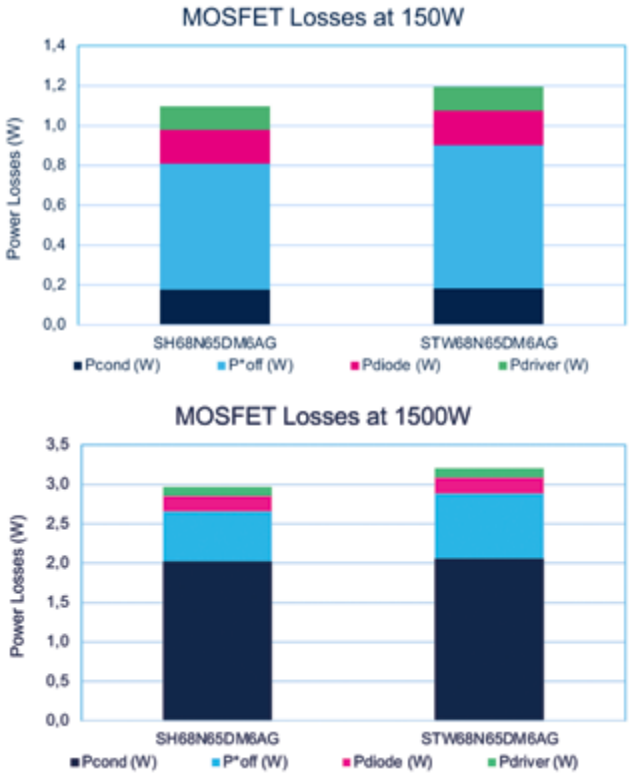

Figure 12: Device power losses

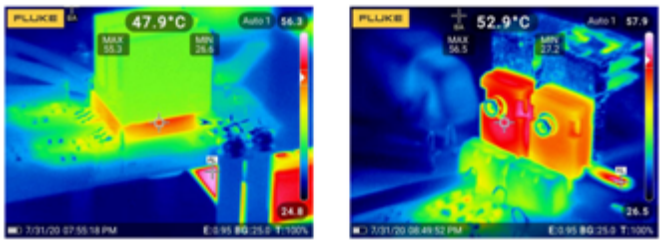

Figure 13: On the left ACEPACK SMIT case temperature at 1500W. On the right TO-247 case temperature at 1500W

Thermal analysis confirms the electrical one, thus SH68N65DM6AG has lower temperature in the entire range respect to TO-247 approach. Of course, the performance of ACEPACK SMIT can be further increased, reducing the value of the RGoff, it is possible to speed up the switching transition and reducing the power losses. Indeed, the smaller overvoltage and less ringing, compared to TO-247, give to the designer some margin for reducing gate resistances.

References

[1] AN5384 - ACEPACK SMIT module package guidelines for mounting and thermal management, STMicroelectronics

[2] AN1703 - Guidelines for using ST's MOSFET smd Packages, STMicroelectronics

[3] F. Scrimizzi, A. Scuto, S. Buonomo and D. Nardo, "ST's MDmesh??? M6 technology improves efficiency in LLC resonant half-bridge converters," PCIM Europe 2019; International Exhibition and Conference for Power Electronics, Intelligent Motion, Renewable Energy and Energy Management, 2019, pp. 1-7.

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Platform for Traction-Inverter Development Eases the Road to Future Mobility

The momentum towards electrified mobility is gathering as governments commit to ending sales of petrol and diesel cars around the 2030 timeframe. The automotive industry, including manufacturers of trucks and buses as well as passenger or specialty vehicles, needs to solve e-powertrain design challenges quickly. However, the technology is unfamiliar and significant engineering resources and time are needed to create a properly developed solution.

By Pierre Delatte, CTO, Cissoid, and David Fresneau, VP Marketing, Silicon Mobility

Silicon carbide (SiC) is the power-semiconductor technology of choice, bringing several advantages to electric drive systems. Its superior switching performance translates into greater efficiency that ultimately extends driving range. In addition, SiC's high breakdown voltage in relation to transistor size and high-temperature capability enable greater power density and enhance reliability.

However, there are differences, when designing with SiC, compared to ordinary silicon MOSFETs or IGBTs. The gate driver design is more complicated, calling for high peak-current capability with careful control of the applied voltage for fast transitions and efficient switching. Safe operation through high voltage transient (dV/dt) and overshoot during high-speed switching is also essential, to make the most of SiC's potential for improved energy efficiency. Another important constraint is that SiC's lower switching losses enable a higher inverter operating frequency, which, in turn, increases the demand on the controller hardware and software to maintain real-time control.

Building an intelligent power module for electric drive is no trivial task. Fortunately, suitable standard modules are becoming available, that can abstract solution developers from basic power-electronic hardware design challenges.

However, finding a suitable module, meeting suitable size, power, and supply voltage requirement is only one part of the puzzle. As delivered, it is not a ready to use solution. Significant additional engineering is needed including developing the software to control the system, as well as working out and implementing adequate cooling.

Figure 1: Cissoid's SiC Inverter platform.

An integrated solution that covers all of these aspects can be particularly valuable to system developers under pressure to meet tight time to market window as demand for EVs and other E-Mobility applications is set to begin rising quickly in the years approaching 2030 and beyond.

Accelerating Inverter Bring-Up

Cissoid's SiC inverter platform (figure 1) alleviates these challenges by bringing together the key elements needed in a drive system, thereby avoiding critical engineering and integration challenges. The platform comprises an intelligent power module (IPM), a controller board and customisable software, a liquid cooler reference design, and a specially designed high-density DC-link capacitor [1].

At the heart of this platform is a family of 3-phase, 1200V IPMs (figure 2) that contain gate drivers fully developed and optimised for SiC application [2].

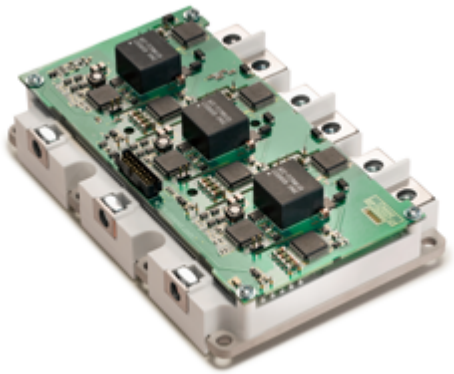

Figure 2: The power module and gate driver at the centre of Cissoid's IPM platform.

Designed using Cissoid's long experience in power design for transportation, aerospace, and industrial environments, the modules deliver an advanced level of integration and high reliability. The portfolio comprises modules with maximum continuous current capability from 340A to 550A. Containing a SiC MOSFET array with low turn-on/turn-off losses of about 7-9mJ at 300A/600V, they also have low on resistance in the range 2.53mΩ to 4.2mΩ.

The optimised gate driver delivers a high peak current, greater than 10A, to ensure fast switching. The gate-driving voltages are tightly controlled, within +/- 5%, and all necessary protections are built-in. These include under-voltage lockout (UVLO) on the primary and secondary sides, desaturation detection and soft shutdown, and negative drive with active Miller clamp (AMC) to prevent parasitic turn-on that can damage the MOSFETs. There is also a PWM glitch filter and PWM anti-overlap protection. The gate driver also features high temperature operation ($T_{ambient}$ up to125°C) and a pow-

er transformer designed for low parasitic capacitance to minimise common-mode current interference.

In addition to ensuring high integration that helps maximise reliability and power density, this turnkey IPM saves up to two years in SiC inverter development. The conduction and switching losses of the power module are known from the beginning and fully characterised. In addition, the optimised gate driver helps minimise the number of iterations to perfect the module performance and thermal management.

Secret's in the Software

Cissoid and Silicon Mobility have partnered in designing the control board to manage the IPM, aiming at accelerating SiC-based e-motor drive development. The board is based on the Silicon Mobility OLEA® T222 Field-Programmable Control Unit (FPCU), which provides real-time processing, control and functional safety optimised for automotive control applications. All needed hardware and interfaces are provided, including CAN, LIN, and SPI. The signals from motor position (resolver, encoder, or magnetic-based), current and temperature sensors are also properly managed by the control hardware and software. Mechanical and electrical integration between the control board and IPMs is completed, which removes another hurdle from the developer's path.

Up to this point, the IPM platform relieves developers of specialist power electronics and hardware design challenges and delivers the advantage of a state-of-the-art compute engine which eliminates processing bottlenecks that often hamper real-time performance of conventional controllers [3]. In addition, the chip is already ISO 26262 ASIL-D functional-safety design ready certified

.

But more is needed. The platform is integrated with Silicon Mobility's OLEA APP INVERTER control software, and developers can use OLEA COMPOSER design tools to quickly develop and optimise the motor-control software. APP INVERTER (figure 3) has advanced control algorithms for highly energy-efficient systems, suitable for a wide variety of motor types, with support for various control and regulation strategies including flux weakening and field-oriented control (FOC), dynamic space-vector pulse-width modulation (SVPWM) or discontinued pulse-width modulation (DPWM), and sensored or sensorless rotor-position detection. OLEA COMPOSER and OLEA APP INVERTER are ISO 26262 certified for system design up to ASIL-D.

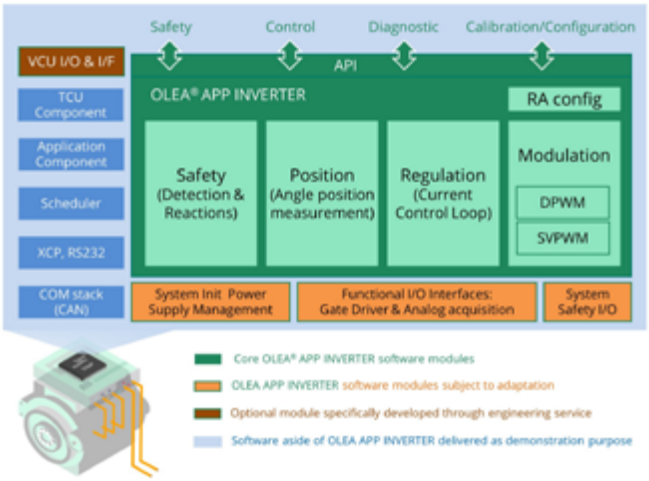

Figure 3: Motor-control software is tightly integrated with the IPM platform.

DC-Link Capacitor

The performance of some aspects of the drive system, such as the DC-link capacitor, often passes under the radar. However, this is an aspect that rewards investment in proper engineering to stabilise the inverter input and provide noise attenuation within a compact footprint and low bill of materials cost.

Cissoid has collaborated with NAC Semi and Advanced Conversion Inc. to create a DC-link capacitor that brings important advantages to automotive electric drives [4]. The resulting integrated capacitor/busbar solution has very low inductance that gives full freedom to take advantage of the fast-switching capability of the SiC MOSFETs. The capacitor topology is optimal for high power density thanks to low series resistance and high amperes per microfarad, that ensures the capacitor to be sized depending on the power inverter control needs rather on its current rating.

Depending on the module power and voltage, a variety of DC-link capacitors is available from NAC Semi, all based on the same design, with operating voltage from 500V to 900V and capacitance from 135µF to 500µF. Figure 4 shows the capacitor installed in the rear of the module behind the inverter and gate driver assembly.

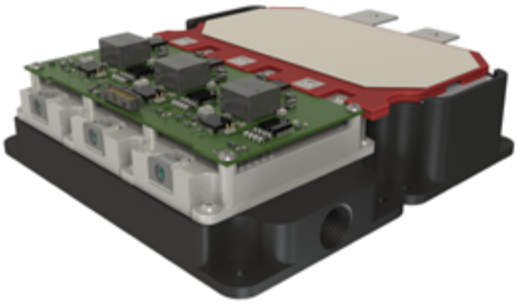

Figure 4: The IPM, comprising inverter, gate driver, and DC-link capacitor.

Keeping Cool

Finally, a reference design and 3D-printed cooler (figure 5) provide a thermally calculated solution for cooling and rapid evaluation of power the module [5]. The reference cooler features a fluid channel, sealing O-rings, and provision for attaching a thermocouple and pressure sensor. Threaded inserts allow the IPM to be bolted directly in place and 19mm hose nozzles are fitted for coolant input and output.

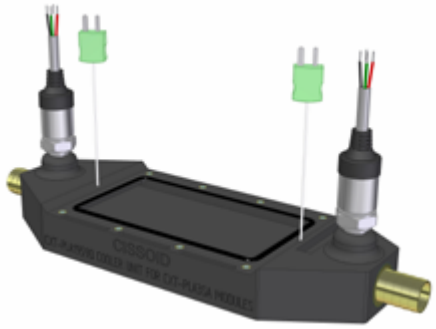

Figure 5: The 3D-printed reference cooler is optimally sized and comes ready to attach the power module and coolant supply.

Proving Performance

LTspice models for the IPM are available [6] and allow modelling of key performance parameters including transistor-level and gate-driver modelling, parasitic inductances, temperature dependence, transient thermal modelling, and switching characteristics including dV/dt, dI/dt and voltage overshoot (figure 6).

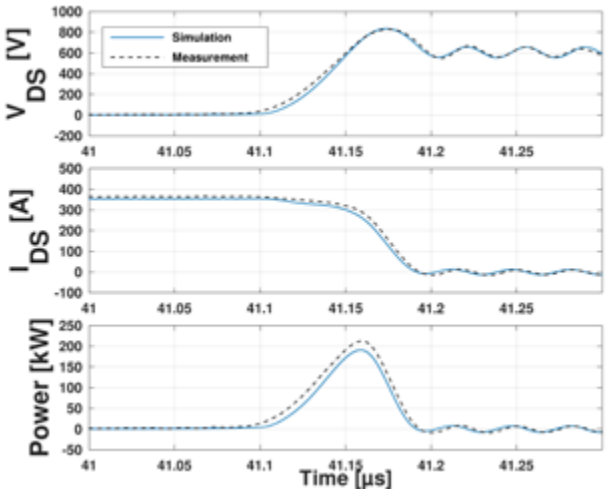

Figure 6. LTspice models facilitate assessment of key parameters including switching: Turn-off waveforms of the CXT-PLA3SB12450AA (V_{bus}=600V, I_{phase}=328A, L_{load}=63µH)

Conclusion

Bringing up a robust and reliable, high-performing electric drive system demands diverse specialist engineering skills and can take two years or more to complete satisfactorily and ensure optimum hardware and software performance.

An IPM platform that combines solutions to the numerous hardware and software challenges reduces the time typically needed to create efficient and compact SiC-based inverters, with fault protection and ready to meet functional-safety standards, to just a few months.

References

[1] SiC Inverter Platform: https://www.cissoid.com/sic-power-modules/#SiC-Inverter-Platform

[2] Pierre Delatte, "A 3-Phase 1200V/450A SiC MOSFET Intelligent Power Module for E-Mobility" in Bodo's Power Systems Magazine, May 2020

[3] Anselme Lebrun, Khaled Douzane, "Software bottleneck removal and design issues solving for high frequency control of hybrid and electric powertrain" EVS30 Symposium, Stuttgart, Germany, October 9 - 11, 2017

[4] Application Note - "DC-Link Capacitors for CISSOID SiC Intelligent Power Modules": https://www.cissoid.com/download/private-documents/dc-link-capacitors-for-cissoid-s-sic-intelligent-power-modules/

[5] Application note – "Mounting & Cooling recommendations for 3-phase SiC MOSFET Intelligent Power Modules CXT-PLA3SA Series": https://www.cissoid.com/download/private-documents/cxt-pla3sa-intelligent-power-module-mounting-and-cooling-recommendations-application-note/

[6] Application Note – "LTSpice Model Library for 3-Phase 1200V/340A-550A SiC MOSFET Intelligent Power Modules Platform": https://www.cissoid.com/download/private-documents/cissoid-sic-intelligent-power-module-ltspice-models/

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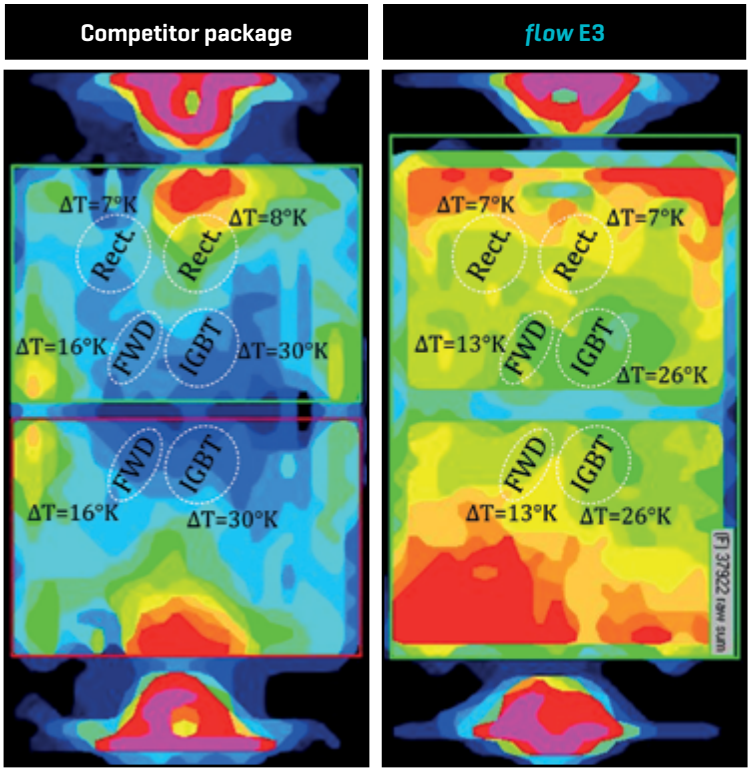

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Higher Performance in Powder Cores Via Improving the Green Density Envelopment

The magnetic powder cores based on atomized Fe-Si-Al particles were widely used in inductor due to its low core-loss, high performance in DC-Bias, and-so on. However, the Fe-Si-Al particles are too hard as steel balls to be molded with high green density body. Adding organic additives into powders could improve mold method and adjust the powder fluidity, and the density and strength of green cores were significantly improved.

By Yangzhong Du, Junwu Nie, and Yongping Li
Hengdian Group DMEGC Magnetics, Jinhua, Zhejiang, China

Introduction

Powder magnetic cores, using metal alloy powder such as Fe-Si-Al (Sendust), are a kind of soft magnetic material or called soft magnetic composites (SMCs). The materials are fabricated by compacting a mixture of resin or other nonmagnetic powder and magnetic alloy powder coated with a thin insulator film. The materials have the following advantages: isotropic magnetic properties, high electric resistivity, therefor their particular magnetic and electrical properties. As an important part of soft magnetic composites, Fe-Si-Al soft magnetic powder cores have been widely used in many electromagnetic devices, such as the reactor, the choke, the filter, the inverter, etc[1-2].

The particle size distribution was found to have a great influence on the core's magnetic properties. A new kind of Sendust materials with fine particle size are manufactured, which has high performance in DC-bias and very low core-loss due to the spherical of particle and increasing the percentage of small particles [3]. But due to adding too much small spherical particles, it is difficult to obtain high-density cores, which could not reach desire magnetic properties. By adding organic or nonorganic additives into magnetic powder, the density, strength and magnetic properties of powder cores are significantly improved.

Experimental Procedure

The atomized Fe-Si-Al powders with sizes <75 μm were commercially purchased. Phosphate insulation coating was applied in this work. The powders were firstly passivated in phosphoric acid solution, containing 2.5 wt% phosphoric acid, and 3.5 wt% alcohol, for 40 min and dried at 85 °C for 20 min. The insulated powders were then blended with 1 wt% - 10 wt% zinc stearate, additives presenting in Table 1, and compacted into toroidal cores, with the outer diameter of 26.92 mm, the inner diameter of 14.73 mm, and the height of 11.00 mm at 1628 MPa. The three kinds of formaldehyde resin, seeing in Table 1 were added into the powders as compared samples and stirred to dry when using solvent. Powders were pressed into toroidal cores as above. The cores were finally annealed in nitrogen atmosphere at 730 °C for 30 min.

The sample's morphology was characterized by a scanning electron microscope (SEM; Phenom Pro X). The core inductance, usually presenting the permeability μe of core, at the frequency (f) 20 kHz and the percent inductance (% μe) at 20 kHz under the DC magnetizing field 100 Oe were measured by an LCR meter (Chroma). The core losses were measured at 50 kHz with the maximum magnetic flux density Bm of 1000 Gs by a power loss tester (BST-2). The strength of cores was measured by a tension meter. All magnetic measurements were carried out at room temperature.

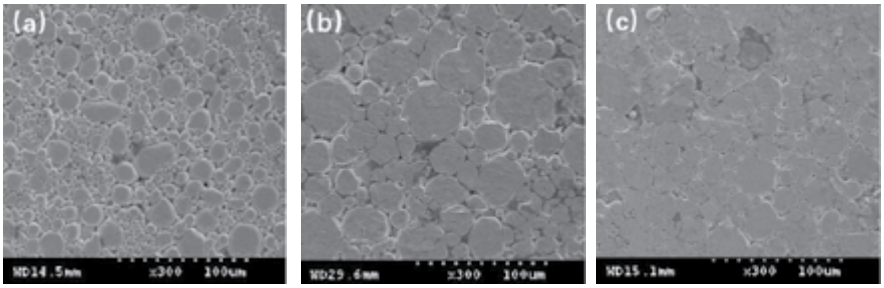

Figure 1: Morphology of cross-section cores with 6% lubricant; (b) 6% lubricant and 6% resin 1;(c) 6% lubricant and 6% resin 2

Results and Discussion

Microstructure

In powder metallurgy processing of mechanically soft magnetic materials, porosity is normally controlled by the compaction pressure. When the pressure is fixed, porosity is controlled by soft magnetic powder and the addi-

	Number of Materials Content					
Code	Materials	1	2	3	4	Characteristics
Additive 1(L)	Zinc stearate	4%	6%	8%	10%	A white light fine powder. Formula is Zn $(C17H35COO)_2$, used as lubricant.
Additive 2(S1)	Silicon resin 1	4%	6%	8%	10%	A kind of silane coupling agent, liquid. Used as surface modification agent.
Additive 3(S2)	Silicon resin 2	4%	6%	8%	10%	Silicon resin, liquid. Used as adhesive and surface modification.
Additive 4(S3)	Silicon resin 3	2%	4%	6%	8%	Silicon resin, white powder. Used as adhesive, high temperature resistance.

Table 1: Additives (include simple code) and the content of each Number presents (wt.%)

tives (usually non-magnetic mater). Fig. 1 shows the morphology of Fe-Si-Al cores in site microstructure, mainly particles are spherical. The sample only with lubricant (Additive 1=L, Table 1) inner was presented firstly, seeing in Fig.1(a), in which the particle boundary is continuous and clear, due to the lubricant burned off during heat-treatment. Meanwhile, the morphology of other two cores, adding silicon resin 1 (Additive 2=S1) and silicon resin 2 (Additive 3=S2), show compacted particles and few residing materials in it, because the additives S1, S2 could remain in poles through the heat-treatment, through them ferreting the strength of cores. But it should be clear that adding non-magnetic materials would decrease the permeability as many studies presenting[3,4]. As for the difference in the resins (S1, S2, Table 1), it is the different mechanism in strengthen, that additive S1 is a kind of high temperature silicon resin, however, S2 resin was usually recognized as a lower temperature kind of resin. When all type resins were burnt at 730°C, and decomposed into different materials, performing a strengthen role or destroying the microstructure in cores[4]. This process variable is relative for changing the compaction pressure and the amount of plastic deformation in the particles, which would also affect the hysteresis loss.

Properties

Several additives as presenting in Table 1 have predictable influences in properties of the cores due to their intrinsic quality. Figure 2 (a) shows the density of each sample after heat treatment, in different conditions corresponding to variable content of lubricant, resin, all being nonmagnetic materials. Obviously, resin 1 (additive, S1) have large influence on the density of the cores, especially with beginning content increasing, for example, larger decrease in density of S1 content 4 wt.% and 6 wt.%, almost 0.23g/cm3 down of density (or in ratio of 3.6% down), while the followed increase of resin 2 (S2) has little effect, for example, from 5.85g/cm3 to 5.79g/cm3. It is also clear that other additives (S3) have few effects in decreasing density compared to resin 1(S1), which is due to little room occupied by those materials, for example, disappeared by high temperature to burned (S3).

	Lubricant (L)				Resin 1 (S1)				Resin 2 (S2)				Resin 3 (S3)			
Content:	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Ratio %	26	26	22	22	28	26	22	20	26	23	20	16	29	26	23	23

Table 2: Decrease of original induce upon each additives effect

Density shows an obviously influence on induce value as shown in Figure 2 (b). In the Figure 2, the higher induce is not found in the core without any additives beside the lubricant, otherwise, the resin 2 (S2) in core

contribute to higher density result in increasing induce as finding in Figure 2(b). With increasing the contents of each additive, induce value decrease as shown in Figure 2, which matched the rule of decrease in induce with increasing content of nonmagnetic additives. Those also should be pointed that the cores with resin 2 (S2) adding show more obvious decrease in induce, as the effect of resin 1 (S1), but density is not influenced by resin 2 (S2). This may result from the pressed procedure, because resin 2 (S2) dissolved in solvent and then added in to SMCs powders, few spaces were occupied by the organic compound in liquid state.

DC-bias properties have great importance on core using in inductor, especially the metal powder core has the special quality, big DC electrical current, low induce decrease, which is benefit to DC-DC change [3]. In Figurte 2(c), the relation between induce decrease under cores applied DC current (called DC-bias) and the additives content is displayed. Firstly, the very important relation is that the decrease degree of induce along with the content of additives, as shown by the curves, for example, the with resin 1 (S1) and without resin in cores, the beginning decrease is 27.9% and 25.8%, displaying the additive S1 negative effect to DC-bias. Although the degree of DC-bias would be close after the additives adding more and more, the lower induce value was found in resin 1 (S1) cores, which was focus in inducer applier. To achieve good DC-bias property, a suitable content of additives like resin or other agents should be chosen correctly, according to total data collection.

Another factor for cores used as inductor is the total loss in core. The losses decreased with the non-magnetic volume fraction up, seeing in Figure 2(d). But there are turning points for each additives curve, that's the 8% in lubricant (additive L), resin 1 (S1) and resin 2 (S2) curves. A special phenomenon was found that the turning points concentrate at the third point for each content of additive, which appears in random without any predesign. All the data of content for additives are displayed in Table 2. Those are important data to make choice while designing an inductor [5].

Additives influence not only electromagnetic properties of cores, but also the physical characters, such as the strength, explored in Figure 2(e). Obviously, the strength of cores after added resin 1(additive S1) show much higher values, that are almost triple of other additives in remaining cores. Usually, strength are the total effect of pressing and annealing, due to particles gap and connection beginning from that. In powder metallurgy processing of mechanically soft magnetic materials, porosity is normally controlled by the compaction pressure. In this paper, three kinds of resin (S1, S2, S3 as in Table 1) were used to increase the strength or filling the gap, getting higher density of cores. The organic resin adhesives, such as polypropylene, epoxy resins and phenolic resins, have been used as coating materials. However, due to their poor temperature toleration, the phosphating-resin materials cannot be annealed above 600 °C. The second resin as in Table 1 are developed due to their good heat resistance, which enables stress-relief at higher temperatures (700°C) without a large increase in eddy current. To avoid such interference, and supposing that pores are just non-magnetic regions in the material, different volume fraction of "pores" could be produced by adding non-magnetic particles to the SMCs powder.

Conclusions

The Fe-Si-Al magnetic cores using spherical atomized powders were prepared. The influence of the additives on the core's electrical and magnetic properties was investigated. It was found that increasing the percentage of each additive result in the decrease of induce (effective permeability) and the improvement of DC-bias performance. With increasing the percentage of all additives resin, the core loss at the frequency 50 kHz continuously decreased. The increase of the hysteresis loss was used to explain the deterioration of the loss due to more gaps. Excell magnetic properties, namely the DC-bias (100 Oe) of up to 74 % and the lowest loss (50 kHz/1000 Gs) of 120 mW/cm-3, were finally achieved in the Fe-Si-Al powder cores.

Acknowledgment

This work was financially supported by the Dongyang Industrial Innovation Foundation.

References

- H. J. Liu, H. L. Sun, W. B. Geng, Z. G. Sun, et al. Effect of Particle Size Distribution on the Magnetic Properties of Fe-Si-Al Powder Core, J. Supercond Nov. Magn. 29(2016)463-468.
- W. Ding, L. T. Jiang, B. Q. Li, et al. Microstructure and Magnetic Properties of Soft Magnetic Composites with Silicate Glass Insulation Layers. J. Supercond Nov. Magn. 27(2014)239-245.
- M. M. Dias, H. J. Mozetic, J. S. Barboza, et al. Influence of Resin type and Control on Electrical and Magnetic Properties of soft magnetic composites(SMCs). Powder Tech. 237(2013)213-220
- I. Gilbert, S. Bull, T. Evans. Effects of Processing upon the properties of Soft Magnetic Composites for Low Loss Applications, J. Mater. Sci, 39(2004)457-461.
- D. Liu, C. Wu, M. Yan. Investigation on Sol-gel Al2O3 and Hybrid Phosphate-alumina Insulation Coatings for FeSiAl Soft Magnetic Composites, J. Mater. Sci., 50(2015)6559-6566.

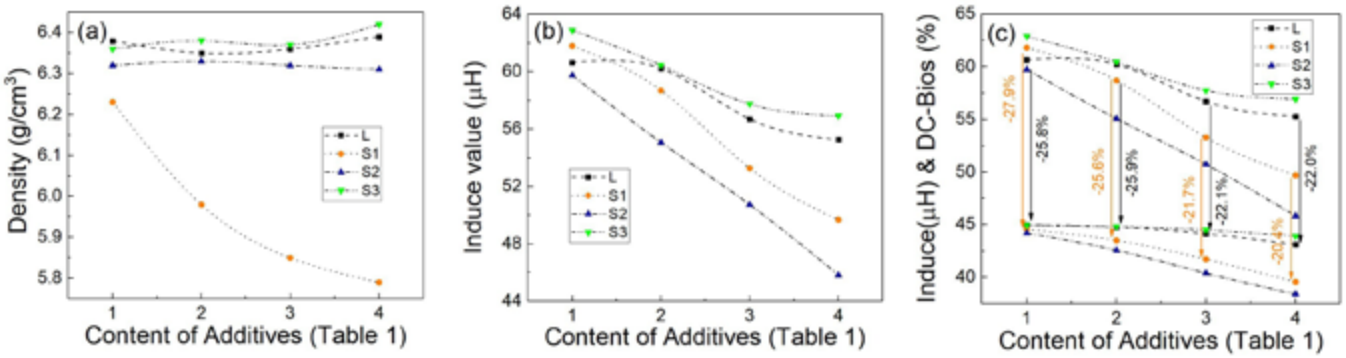

Figure 2: Physical and electromagnetic properties of cores with different additives
(a) Densities of the cores after heat-treatment; (b) Inductance; (c) Decrease of inductance under DC-bias applied; (d) Total loss of the cores; (e) Strength of the cores pulled abruption

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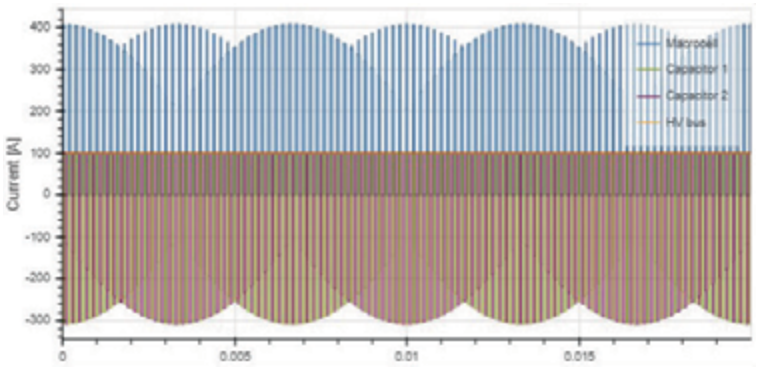

200 kW 3-level NPC converter - DC bus current waveforms

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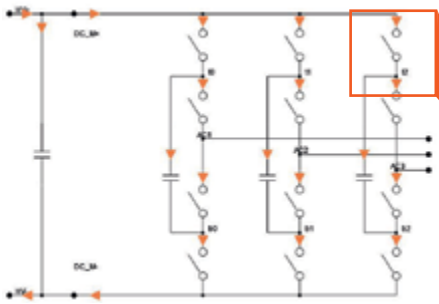
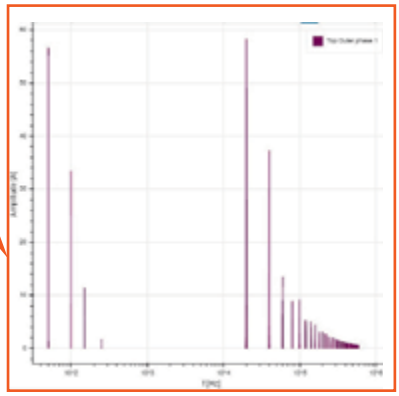
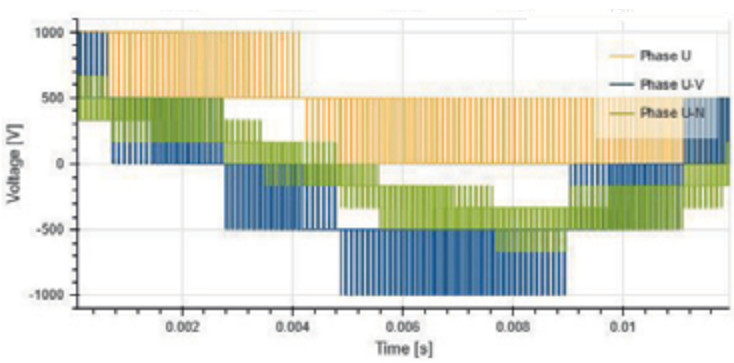


3-level NPC converter electrical diagram



Fourier series of AC current through top outer switch



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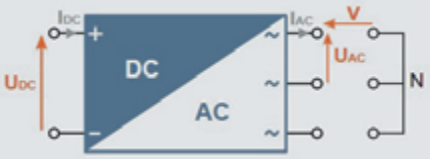

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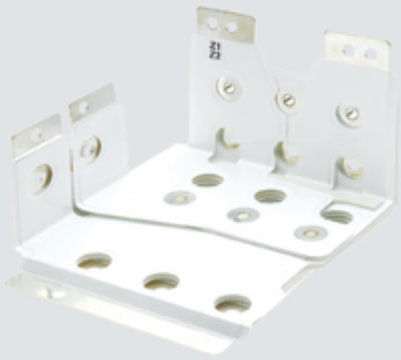

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Gallium Nitride and Silicon Carbide: Compound Materials for Radiation Hardened Applications

For long time, silicon-based devices have represented the baseline standard in the semiconductors landscape. Starting from 2007, due to Moore's Law failure, composed material have been developed with special focus on wide bandgap semiconductors (WBG): they allow to leverage on many important features which make possible the realization of devices with superior performance if compared to traditional Silicon counterparts, for instance in power electronics applications.

By Giuseppe Vacca, PhD, Project Engineer at MERMEC SpA, Monopoli (BA), ITALY and Cristoforo Marzocca, Associate Professor at POLITECNICO di Bari, ITALY

The most mature WBG semiconductor materials already developed are Gallium Nitride and Silicon Carbide; devices based on these kinds of materials, such as GaN HEMTs and SiC MOSFETs are becoming the solutions of choice to manage high power levels in very fast speed switching equipment and exhibit better performance in many key applications if compared to Silicon power devices like IGBTs and Power-MOSFETs.

Since the new WBG semiconductor devices are capable to manage higher power densities than traditional ones, it is possible to obtain significant size reductions with the same level of performance, simplifying thermal management, saving heatsink and related costs: improved breakdown voltage, high electron mobility and saturation velocity make them the right choice in high-power and high-temperature applications.

Furthermore, higher values of critical electrical field make these compounds very attractive for the realization of power switches with outstanding values of specific Rds-on, i.e. the conduction-state equivalent resistance. Based on these new key factors, a significant reduction of power losses in the on-state can be achieved. At the same time, this kind of new devices are also capable of reducing switching power losses thanks to the input capacitances lower than silicon power transistors.

Advantages of WBG devices in terms of efficiency and power density are undisputed.

The pursuit of improvements in these two key characteristics drives innovation in several global industrial areas today, such as data centers, renewable energy, consumer electronics and EV and autonomous vehicles: GaN ad SiC components can provide great power density and more efficiency than their traditional competitors and these improvements result in a large range of benefits for both consumers and companies, whether it be a smaller form factor or faster charging rate in consumer adapters or cooling costs saving and power waste in data centers.

Even in RF and microwave applications, requirements for higher and higher working frequencies cannot be easily managed with the available Silicon RF power devices.

Due to low breakdown voltage, it is impossible to design and fabricate silicon transistors capable of delivering radio-frequency output powers on the order of few hundreds or thousands of watts and this issue has severely limited the use of solid-state devices in high power RF and microwave applications. Recent improvements in the growth of wide bandgap semiconductor materials such as SiC and GaN, allow producing devices with impressive RF performance, offering the opportunity of developing new designs based on microwave solid state transistors, which exhibit performance previously achieved only by using microwave vacuum tubes.

Another very interesting advantage of Gallium Nitride and Silicon Carbide based devices over standard silicon technology, is the high level of radiation hardness shown by these two compound materials, which open doors to a large spectrum of applications in the military and space markets. Damages and malfunctions due to ionizing events in harsh radiation environments are tolerate much better by GaN and SiC devices as compared to their Silicon counterparts.

Power Devices: effects of radiation

In general, severe requirements for radiation hardened electronic systems must be satisfied in several applications, so as to guarantee that electronic devices and circuits are able to tolerate damages caused by high levels of ionizing radiation and/or high-energy electromagnetic radiation typical of environments such as the space and high-altitude flights, particle accelerators and nuclear reactors, including nuclear accidents.

Unfortunately, some kinds of semiconductors are susceptible to radiation damage and radiation-hardened components can be realized by appropriate design and manufacturing variations, useful to reduce their susceptibility to radiation induced damages.

For example, distributed MOSFET structures having enclosed gate layout equipped with guard rings of annular form; exhibit enhanced resistance to the effect of ionizing radiation. Other examples of solutions are represented by ringed sources or double drain techniques.

The space environment, in particular, can present conditions capable to influence and in many cases degrade the characteristics of devices and materials affecting as a consequence the correct operation of important systems.

The main requirement for space qualified devices a high level of reliability for long term operation, in fact, radiation effects produce interruptions, degradations and in general discontinuities in devices performance.

Electronic devices used for space applications are subject for instance, to damages caused by protons and electrons which are trapped in the Earth's magnetic field; space radiation flux consists mainly of 85% protons and 15% heavy nuclei; these effects are called Single Event Effects (SEEs). Another important effect due to space radiation is represented by the Total Ionizing Dose (TID).

The difference between the two concepts is quite simple:
SEE is the result produced by a single high-energy particle hitting

the electronic device, whereas TID is related to the effects produced by prolonged exposure to ionizing radiation.

In the case of electronic devices, TID is typically measured in "rad" (radiation absorbed dose) which is one of the units used to measure the total amount of radiation absorbed by a material, an object or a person; it reflects the total amount of energy deposited in the materials exposed to radioactive sources.

The absorbed radiations dose, expressed in rad is the amount of energy (coming from whatever kind of ionizing radiation) deposited in any substance like water, air or tissue; a dose of 1 rad corresponds to a total energy of 100 ergs deposited in 100 grams of material. In the International System, the unit of measurement for the total irradiation dose is the Gray (Gy): 1Gy is equivalent to 100rad.

Considering a specific device, its dose radiation threshold represents the minimum level of TID that causes a failure of the device: most commercial devices declared "radiation hardened" are able to withstand up to 5krad before a functional failure occurs.

Radiation-hardened products are generally tested for one or multiple concurrent effects for instance TID ELDRS (Enhanced Low Dose Rate Effects), displacement damage from neutrons and protons.

Regarding single event effects, they play a very important role in environments such as spacecrafts and satellites because of the high flux of protons and ions present in the environment where these systems work.

A series of different types of SEEs in electronic circuits can be identified as follow:
SEU (Single Event Upset): it represents a change of state, typically in a digital circuit, due to one single ionizing particle (ion, electron, photon...) striking a sensitive point in an electronic device.

SET (Single Event Transient): it occurs when an energetic subatomic particle strikes a combinational logic element. The charge deposited by the particle causes a transient voltage disturbance that can propagate to a storage element and is latched, resulting in Single Event Upset.

SEFI (Single Event Functional Interrupt): it is a temporary failure (or interruption of normal operation) on the affected devices caused by a single particle strike.

SEGR (Single Event Gate Rupture): it is an event in which a single energetic particle causes a breakdown of the thin gate oxide of MOSFET, creating a conductive path through it. This event is revealed by an increase in gate leakage current and can result in either the degradation or the complete failure of the device.

SEL (Single Event Latch-up): it indicates an abnormal high current state in a device and is caused by the passage of a single energetic particle through sensitive regions of the device structure resulting in a device functionality loss. SEL could cause permanent damage to the device and if the device is not permanently damaged, it is mandatory to execute a power cycling (off/on) to restore normal operation. SEL occurs in CMOS structures where an intrinsic parasitic p-n-p-n structure (in practice an SCR) is turned on by the absorption of a single particle and induces the creation of a short-circuit between power and ground.

SEB (Single Event Burnout): it represents an event in which a single energetic particle strike induces a localized high current state in devices that causes catastrophic failure.

All types of SEE events can cause system performance degradation, possibly to the point of total destruction. In order to ensure a high degree of reliability, it is necessary to select components in which the effects produced by radiation have been measured, recorded and declared.

As described above, electronic devices suffer radiation effects, especially due to electrons and protons and the main reasons of their production are Solar Energetic Particle Events where the Earth's magnetosphere dips closest to the earth, causing more trapped radiation.

With reference to traditional Silicon technology, long-term cumulative ionizing damage coming from protons and electrons is represented by two types of radiation damages for MOSFET devices working in hostile radiation environments: surface effects due to phenomena such as charge trapping at oxide interfaces and bulk damages as result of ions displacement.

These effects produce significant worsening of the device performances resulting in threshold voltage shifts (see Figure 1), transconductance degradation (see Figure 2), increase of leakage current (and related power consumption), alterations of the dynamic characteristics, reduction of efficiency in switching performance, etc.

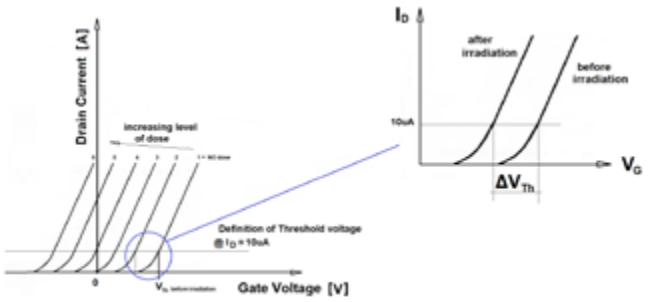

Figure 1: Threshold voltage shift due to Irradiation Effects

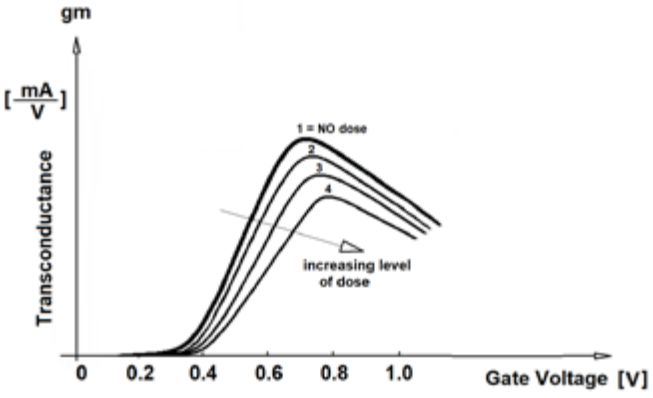

Figure 2: Transconductance degradation due to Irradiation Effects

Incident radiation produces hole-electron pairs into the oxides, and as a consequence trapped holes into gate oxide induce threshold voltage shifts, whereas trapped holes into field oxide cause an increase in the leakage current. NMOS transistors result more vulnerable than PMOS transistors as far as these phenomena are concerned.

As a possible solution to alleviate the above-mentioned issues, metal shielding can be adopted to cover the device.

This arrangement could be of help, but several relevant factors must be considered to assess its effectiveness, for instance shield geometry to be studied with suitable ad hoc analysis techniques, shield material composition and device composition. Electrons can be effectively attenuated by an aluminum shielding even in case of high energies; aluminum shielding works well also for low-energy protons, but it is ineffective for high-energy protons, greater than 30 MeV.

What are WBG advantages in space and military systems?
Power devices used for critical applications such as strategic mili-

tary equipment, space missions and satellite applications, spacecrafts, high-altitude flights and drones, data transmission and robotics must be resistant to failures and malfunctions caused by ionizing radiation.

In these kind of applications WBG devices offer significantly higher performance than traditional silicon-based rad-hard devices.

This feature makes feasible the implementation of innovative architectures because size reduction combined with decrease in weight, together with high efficiency and good reliability are the basic requirements for any device intended for the above-mentioned applications.

Gallium Nitride and Silicon Carbide are able of providing the highest level of efficiency with the smallest footprint available nowadays among all existing devices. They also have excellent performances as far as Electromagnetic Interference (EMI) is concerned, thanks to the reduction of parasitic capacitance values and consequently the decrease of the energy stored and released during the switching cycles. At the same time, the reduced dimensions improve the loop inductance, so that antenna effects are quite attenuated.

Rad-hard Silicon MOSFETs have already reached their limits due to no so recent technology because they have got large die sizes with the Performance Figure of Merit (FOM) being very high if compared to new WBG transistor, especially with enhanced-mode GaN devices.

Related with previous figure, an important parameter to assess devices performance is the FoM (Figure of Merit) defined as $FoM = R_{DS(ON)} \times C_{iss}$

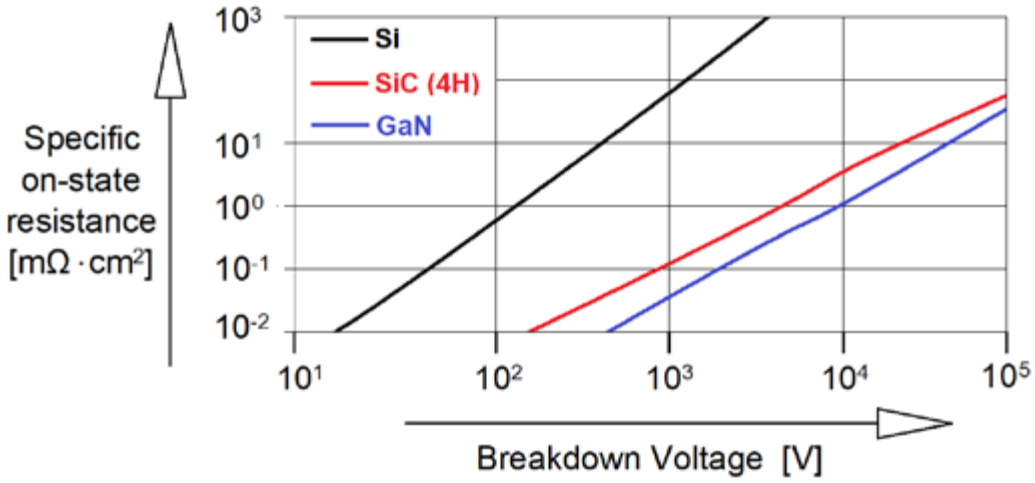

Figure 3: Performance comparation

It represents the deviation from ideality of device and the lower its value, the better is the system efficiency.

WBG radiation hardened solutions

Enhanced-mode GaN HEMTs transistors are quite easy to drive because they require up to 40 times less gate charge if compared to the best rad-hard MOSFETs. This is due to physical dimensions that are favorable for GaN devices: they can be mounted directly on the ceramic substrate avoiding any additional external package.

In this way it is possible to eliminate any wire bounding and consequently the related degeneration inductances disappear, allowing very high switching rates, limited only by resistances and capacitances associated to the gate and drain nodes.

As a consequence, the operating frequencies can be increased a lot, thus achieving switching times of the order of nanoseconds. For these high-speed applications, particular attention shall be paid in the layout design phase.

Several important players in the field of WBG advanced solutions have developed radiation hardened, high performance GaN FET devices suitable for DC-DC converters and, in general, for switching power supply applications in space borne systems. These components have been characterized against destructive Single Event Effects (SEE) and tested for high level of Total Ionization Dose (TID).

These 100V and 200V GaN FETs with maximum drain current up to 60Amps, are capable of performing up to 10 order of magnitude better than silicon MOSFETs, reducing the package size approximately of 50%.

They also reduce power supply size, weight and cost, saving a part of heat-sink due to lower switching power loss. Furthermore these devices are the best in class because they show the best FoM with 5mΩ RDS(on) and 14nC gate charge.

For instance, the SGRB series of DC-DC converters from VPT make use of advanced GaN technology and has been expressly designed and qualified for space applications and, in general, harsh radiation environments. The above mentioned series is radiation tolerant, low noise and exhibits very high levels of efficiency, above 95%, which compares favorably to traditional radiation-hardened silicon products.

A wide family of Adaptor Modules, based on high-reliability GaN devices, is available for multi-function power applications. They exploit eGaN switching HEMTs with high-speed gate driver circuits.

Electronics solutions have become more and more widespread in today's aerospace environments and applications and all the developers are working hard on an increasing number of systems, such as satellite and spacecraft equipment. High efficiency coupled with good reliability are essential for the success of a space mission project.

Additionally, the capability of wideband semiconductors to operate in high temperature environments has important implications, because this paves the way to their applications in extreme heat environments, at the same time requiring less cooling for proper operations.

Usually, irradiation tests of electronic devices are performed in accordance with MIL STD-883E and ESA-SCC 22900 standards.

These standards define and regulate methods and requirements applicable to the steady-state irradiation testing of integrated circuits and discrete semiconductor devices suitable for space applications and describe measurements and procedures for testing microelectronics devices suitable for military and aerospace electronic systems, including basic environmental tests to determine resistance to destructive effects of natural elements and conditions typically in military and space operations.

On the one hand SiC power MOSFETs demonstrate good tolerance to gamma-rays and neutrons irradiation, but at the same time they have quite low tolerance to Single Event Effect phenomena (SEE) induced by high energy heavy ions. On the other hand, GaN transistors tested with gamma-rays exhibit a remarkable hardness with respect to the total dose and displacement damage.

In more detail, under irradiation with gamma-rays, neutrons and heavy ions in a large range of energies [20MeV÷550MeV], SiC power MOSFETs show good performances in terms of sensitivity to Total

Ionizing Dose, whereas they present a quite poor SOA (Safe Operating Area) for what concerns Single Event Effects (SEE); instead, irradiating GaN transistors with gamma-rays, neutrons and heavy ions and low energy protons, they exhibit a very good SOA toward SEE.

After an irradiation test, gate leakage currents of the device can increase by up to an order of magnitude, with a threshold voltage reduction up to 1 Volt and a remarkable drop of transconductance value.

Conclusion and ongoing activities

According to the previous discussion, wide bandgap devices have become strategically important for the development of next generation space systems.

While important results have already been demonstrated, a lot of research and development work remains to be done to mature these news technologies and ensure their suitability for use in space applications.

European Space Agency (ESA) has been working for over 10 years to enhance the quality of crystalline materials for the realization of devices with improved reliability and performance.

Further research work activity has been planned to improve material growth processes while optimizing devices performance, in order to qualify WBG devices for use in space applications. More additional tasks have been foreseen, for instance to develop advanced packaging with appropriate solutions.

In particular, ESA based in Estec (The Netherlands) has launched an extensive portfolio of activities specifically related to WBG materials, such as SiC, GaN and Diamond. Their specific purpose is to better understand and optimize the manufacturing process of WBG components, so as to achieve high reliability operation in space applications.

One of the world's first demonstration of a GaN based X-band telemetry transmitter, installed on board of the satellite called "PROBA-V" has been developed in this framework, in order to stimulate the creation of a European supply chain dedicated to WBG component technology.

Further activities are planned with the purpose of demonstrating the superior performance of these new technologies in terms of high operating frequencies, high operating voltages and increased working temperatures, for instance in advanced sensors for photonic applications.

References

- A. Bolonikov et al, "Overview of 1.2kV–2.2kV SiC-MOSFETs targeted for industrial power conversion applications", IEEE 2015.
- Alexis C. Vilas Boas et al, "Assessment of Ionizing Radiation Hardness of a GaN Field-Effect Transistor", IEEE 2019.
- Alexis C. Vilas Boas et al, "Ionizing radiation hardness tests of GaN HEMTs for harsh environments", ScienceDirect, Jan 2021.
- Xingguang Zhu et al, "Radiation Hardness Study on SiC Power MOSFETs" NASA Poster 2017.
- G.Vacca, C. Marzocca "New Gallium Nitride Transistor Technologies", Journal of Electronic Devices, 2013.
- Jon Azurza Anderson et al, "New Figure-of-Merit Combining Semiconductor and Multi-Level Converter Properties", IEEE, 2020.

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Redefining Automotive Power Delivery Networks

An Opportunity to Save Weight and Cost

The growth in EV adoption is a clear and obvious trend, confirmed in several recent industry reports. While the pandemic paused car sales globally, consumers have had time to reflect on their vehicle replacement options, and it appears many are considering an EV as a viable choice. However, many potential obstacles to widespread consumer adoption exist, the most notable being range and charging time anxiety.

By Mark Patrick, Head of Technical Marketing EMEA, Mouser Electronics

Still, thanks to many national and regional Government initiatives, and manufacturer special offers, EV sales are set to grow significantly in the coming years.

From the vehicle manufacturer's perspective, there are still many technical challenges to address moving forward. The initial development of EVs sought to add EV alternatives to existing brand models for the early adopter market. However, sustained and significant growth will require technological advancements on many different fronts.

Battery design, for example, is undergoing major innovation into new chemistries and methods of construction. Although these developments are still in their infancy, there are promising results already. The deployment of a convenient and easy to access EV charging infrastructure requires significant investment too. Range and charging time remain top consumer considerations, along with price, but the key factor impacting these is the vehicle's weight.

EVs today still maintain a 12 V battery to power non-traction related functions such as windscreen wipers, seat comfort controls, and infotainment. Some manufacturers are currently replacing a 12 V battery with a 48 V for new models.

The Low Voltage Legacy

Any new vehicle today is equipped with a myriad of electronics-based features, a far cry from when the Hudson Motor Company introduced the concept of a standardized battery in 1918. Today, a sleek touch-controlled infotainment system typically incorporates radio, media players, a GNSS navigation system, smartphone integration, and vehicle status and systems configuration menus. In addition, vehicle occupants can stream music from their smartphone, a high-capacity SD card, or an online service. Advanced driver assistance systems (ADAS) use combinations of RADAR, LiDAR, and machine learning-based computer vision to deliver comprehensive driving aids like adaptive cruise control (ACC), blind-spot detection, and emergency braking. The advances in automotive technologies are impressive, but they all share a legacy of the past; the traditional 12 V battery powers them.

For EVs equipped with a 400 V or 800 V battery pack, incorporating an additional battery and the associated power management electronics to power everything highlighted above would appear to incur an unnecessary bill of material cost. Figure 1 illustrates how complex the hybrid and fully EV power architectures have become compared to the internal combustion engine.

In the past, manufacturers packaged individual system functions in separate electronic control units (ECU), each powered with a 12 V supply. This distributed approach to power management and conversion results in high BOM costs. Of course, BOM cost isn't the only factor to be considered though, since the weight of a 12 V primary battery and all the power components represent a significant payload. For example, the average weight of a 12 V starter battery is 20 kg, which, together with the excess power conversion components, can quickly become significantly increased.

Viewed another way, from the DC/DC power perspective, an electric vehicle power train introduces the need for 50 kW and upwards power conversion and management compared to < 3 kW for a conventional internal combustion engine vehicle. Therefore, achieving reliable and efficient power conversion in the minimum space and with the lowest weight becomes crucial. An EV power architecture needs to support the drive power train, onboard and infrastructure charging, and legacy systems.

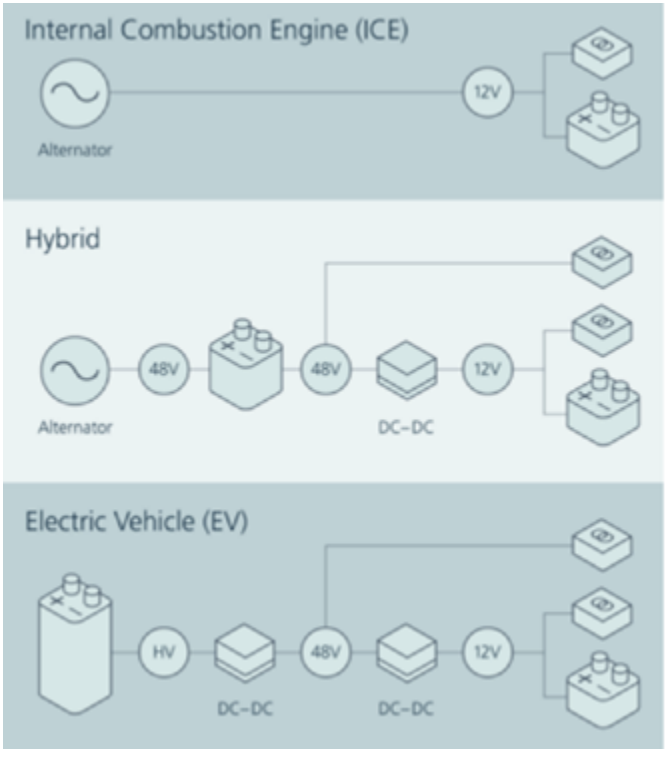

Figure 1: A comparison of power architectures used in internal combustion engines, hybrid and fully electric vehicles (source Vicor)

Automotive Power Deliver Architecture; A Different Approach

A viable approach to solving an electric vehicle's development challenges proposed by Vicor is to use a virtual 12 V (or 24 V/ 48 V) battery - see in Figure 2. Rather than rely on a separate 12 V battery, why not create a virtual battery directly from the vehicle's primary 400 V or 800 V battery pack? With this approach, manufacturers can save weight together with a reduction in the associated, engineering, supply chain and stocking costs.

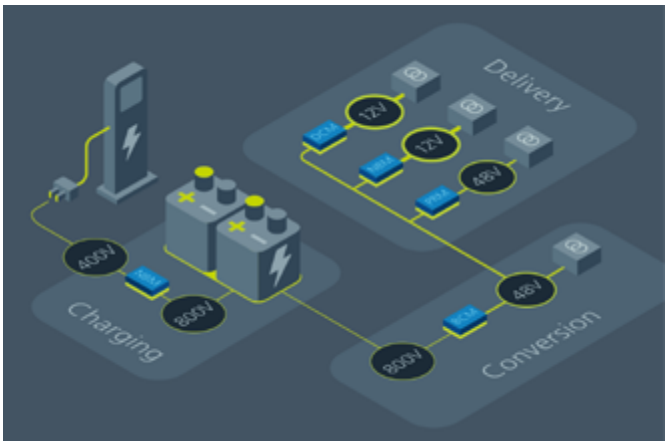

Figure 2: Implementing an EV power architecture with virtual battery 12 V and 48 V sources - (source Vicor)

By incorporating high-density HV to LV conversion modules into existing sub-systems, the Vicor approach also achieves a higher degree of integration and a reduction in BoM cost – something OEM's wish to achieve too

The Vicor proposal focuses on three aspects of the power delivery network architecture illustrated in Figure 2; charging, converting, and delivering.

EV Charging: The EV industry is gradually adopting the 800 V operating voltage for battery packs, but much of the EV charging infrastructure deployed is based on the initial 400 V standard. Therefore, any new EV needs to be able to accommodate both voltage levels. Efficient and straightforward bi-directional conversion modules are already available that offer an extremely flexible, high-efficiency and high-density scalable solution for battery-to-charger station compatibility.

Power Conversion: Conversion of an EV's primary high voltage battery using a high-density automotive-qualified DC/DC module offers considerable weight and space savings for automotive manufacturers. Again, bi-directional power conversion capabilities provide flexibility of power delivery architectural design. The ability to eliminate the need for a 48 V intermediate energy storage, where used, by a virtual 48 V battery from the HV battery, further provides weight and space savings.

Virtual Power Delivery: In newer vehicles, 48 V applications include new drive, steer and brake-by-wire high power systems. Meeting the power delivery requirements of these networks while supporting legacy 12V loads (see Figure 3) with increased power requirements needs careful consideration. Compact high-density module solutions that are smaller and lighter than legacy solutions are available from Vicor.

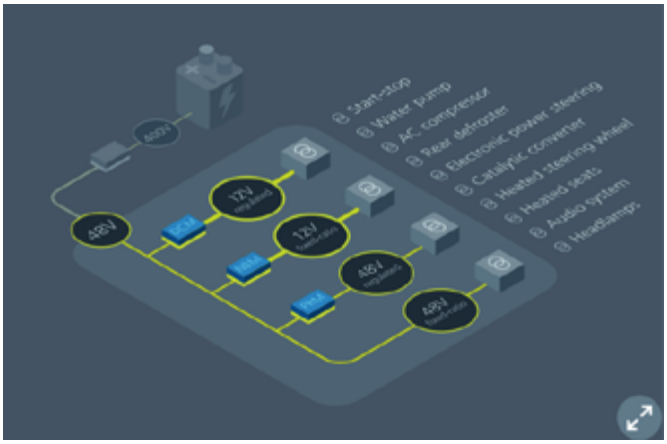

Figure 3: Supporting legacy 12 V applications through a virtual power architecture from the vehicle's HV battery (source Vicor)

Redefining Automotive Power Delivery Architectures

As automotive OEMs grapple with lowering CO2 emissions while increasing vehicle performance and functionality, electric vehicles are proving to be the best option. However, keeping electric vehicle weight to a minimum to achieve a better range is proving to be a challenge. Redefining the architecture of a vehicle's power delivery network saves both weight and system costs.

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Engineering: No Place for a Woman?

Globally, it is estimated that only 30 percent of researchers in the Science, Technology, Engineering and Math (STEM) fields are women, and that number decreases as we increase in seniority and prestige the Nobel Prize's shortlist of women is one example. Of all Nobel laureates in Physics between 1901 and 2021, only 4 have been women and none from Asia.

By Hexagon's Manufacturing Intelligence Division

This skills and gender gap are not to be taken lightly. The 2020 Global Engineering Capability Review recognised that the skills gap in engineering will also impact areas of the United Nations Sustainable Development Goals in terms of clean energy, sustainable cities and climate action. A research, commissioned by the Royal Academy of Engineering and the Lloyd's Register Foundation, found that while engineering provided an important lever for countries to fulfill UN goals, it could not do so without a sufficient pool of talent with the necessary capabilities. Finding the solution to the skills shortage will require effort to build, involve and engage with more women. This year, in conjunction with International Women's Day 2022 and World Engineering Day 2022, four female leaders within Hexagon share: How far have we come, and how much further do we have to go to break the bias and to build back wiser for a better future.

Kanokrat Densirisopa

Kanokrat Densirisopa is Sales Manager of MSC Software Corporation, part of Hexagon for Thailand. She is in charge of engineering solutions products with close to a decade of experience having graduated with a Bachelor of Chemical Engineering from Kasetsart University, Thailand. Her specialties are in the areas of electric vehicles and autonomous technologies.

What drew you to this field in engineering?
I have always been interested in technology and future solutions. Engineering, for me, offers solutions and tools for productivity; enabling people and companies to work better and faster while simultaneously creating new opportunities and futures. Technology makes perfect business sense -- if you do not innovate, invent and upskill with technology, someone else will. And I want to be in the forefront.

So much has been written about women in tech/engineering, have you seen a difference since the time you started?

Compared to 10 years ago, women now have more confidence in technology and innovation than they did when I first started as a sales engineer for a Computer Aided Design (CAD) software product. There are far more opportunities available to us, but it's been a long journey to get here. The value of women in the workplace is now finally beginning to be recognised and far beyond just being a good business strategy, empowering women is the key to success.

How do we encourage young women to get into this field?
Young women are interested in technology and have the potential to bring huge change and impact to industries, but these interests need to be cultivated, encouraged, and nurtured from a young age for women to be confident in these areas, and take a position in industries.

What do we need to do to break the bias? How far do we have to go to change the perception that engineering is a man's world?
There is growing awareness and decisions on gender inclusivity and on improving gender parity at the workplace across industries. I believe there will be many more women working in the engineering field. I think to help push further, we should stop limiting women from any kind of work, not only in engineering but in all fields.

How does Hexagon support women in engineering, driving impact?
I'm so proud to work for a company that does not let gender be a barrier of work. Hexagon is a large company, but it's close-knit; I have never felt discriminated against on the basis of gender here.

Hanxue Zhao

Hanxue Zhao is Vice President of Global Electronics Industry Lead in Hexagon Manufacturing Intelligence. She spent over 20 years living and working internationally. She is highly motivated, with team management, business development, and technology sales experience in multinational corporations in the high technology and instruments sectors. She holds a doctorate PhD in Microelectronics from the Nanyang Technological University in Singapore. She now leads teams in emerging technologies surrounding 4IR.

What drew you to this career path in engineering?
It's the nice combination of engineering and creative nature of the role, with numerous opportunities to inspire others, as well as the unimaginable diversity and possibility.

So much has been written about women in tech/engineering, have you seen a difference since the time you started?

Whether male or female, we need to work hard to prove ourselves and gain respect, the difference lies in the perspectives and mindset that women bring to the table.

How do we encourage young women to get into this field?
Engineering is a field where intelligence and hard work are recognised and rewarded. Historically, this has been male-dominated - which can be intimidating, leaving women to feel unwelcome in the industry.

How does Hexagon uplift women?
Hexagon has numerous programs developing women in leadership where we are encouraged to perform and grow. It provides an inclusive and robust environment for women to thrive. In 2021 Hexagon conducted a women mentoring program to help empower and mentor women within the Manufacturing Intelligence division by developing meaningful relationships, expanding knowledge about Hexagon and the industry we operate in and providing experiences that will advance skills needed to thrive professionally.

Hexagon has also made a commitment that by 2030, 30% of its leadership will comprise of women. This is great news as we embrace diversity in the workplace!

What do we need to do to break the bias? How far do we have to go to change the perception that engineering is a man's world?
To break the bias, and to remove the hidden barriers, we must encourage women to set aside pre-conceived notions that "science is not for us" and be encouraged to pursue our interest and passions in the field. That has to start from the day girls are in school, and continue to be cultivated and nurtured until they enter higher education.

Women also overwhelmingly drop out of these fields due to family commitment-- to resolve this, women need to be given every support, from creches to childcare and maternity options at the workplace, enabling them to better balance life priorities in order. This will enable her to better contribute to the growth of the organisation.

Khoo Siew Fang

Khoo Siew Fang who is currently Country Manager of Hexagon Manufacturing Intelligence Malaysia, with over 18 years of experience in engineering, sales and leadership - instrumental in the continued growth and development of its business here.

Having completed a Bachelor Degree in Environmental Science and a Diploma in Civil Engineering, she started her career as a scientific instruments solution provider for research and education, environmental works, and hydrogeology. She then moved on as a technical specialist and now lends her skills and expertise in the area of smart manufacturing and metrology.

What drew you to this industry?
Metrology, the scientific study of measurement, is a niche market that is very interesting for me to learn and explore. I like the differentiation and high-level expertise that this field offers.

So much has been written about women in tech and engineering - have you seen a difference since the time you started?
Since the beginning of my career, I have seen female participation growing steadily but still at a slow pace. It could take many more years for women to gain equal representation in tech and engineering. There are many levers we can apply to accelerate the pace of change - but more importantly, it needs to be done consistently

and collectively. By this, I mean that it takes leaders, teachers, parents and the whole of community to recognise firstly, the importance a scientific mind, and to continually foster that for girls. The career path for women in traditionally male-dominated industries can sometimes be fast-tracked as more companies are cognisant of the value of women leaders - in management and Board levels.

How do we encourage young women to get into this field? How can we #buildbackbetter?
UNESCO's report "Cracking the code: Girls' and women's education in STEM", found that only 35 percent of STEM students in higher education globally are women. On average worldwide, women accounted for less than a third (29.3%) of those employed in scientific research and development (R&D). The numbers do not lie: gender parity in roles related to science, technology, engineering and innovation continues to escape a certain reality in spite of women making up half of the world's population.

So I say: we must be a bridge for young women. More of us need to speak with young women who are in need of role models. Mentorship programs to provide young women with the ability to receive hands-on, skills-based advice as well as networking and practical tech career advice. It is important for us in this field to uplift each other and continue to create opportunities for each other.

Hexagon's diversity and inclusion: How does Hexagon uplift women?
At a recent Hexagon regional meeting, I shared Malaysia's wins in Q-DAS (software for Statistical Process Control and data management) and electronics. There have been many occasions where the agenda has been designed to be inclusive. Hexagon provides a level playing field, and recognises how we can come together to contribute to the greater success of our customers, the organization and more importantly, people and the planet.

What do we need to do to break the bias? How far do we have to go to change the perception that engineering is a man's world?
Women engineers have already shown what we can do in the profession, and in time this will lead towards equal representation and equality. Continued motivation, passion, and opportunistic attitudes are needed to help women get ahead in their engineering careers.

Leanne Kam

Leanne Kam is Senior Sales & Application Manager. She started her journey in precision engineering from the school bench, some 14 years ago. This stoked her passion about Industrial metrology, leading to a career as an application engineer while pursuing Mechanical Engineering in the National University of Singapore. She now lends her skills and expertise in the area of smart manufacturing and metrology.

What drew you to a career in metrology?
It was interest and curiosity that drew me into engineering. Job satisfaction kept me in this field. I grew to love and appreciate precision measurement technology through my work. What I enjoyed most was helping customers solve their quality issues using the right measurement strategy and technology.

So much has been written about women in tech and engineering, have you seen a difference since the time you started?
The engineering industry was still predominantly male when I first started in the early 2010 s. More women are now in engineering and this is a good sign! It is good to see we can now pursue our dreams, breaking previous stereotypes.

How do we encourage young women to get into this field? How can we build back better?
Fundamentally, encouragement from families goes a long way, especially during the formative years. If a family member goes "women don't need to do engineering, just find a simple desk job will do", it creates a negative image of engineering that might resonate in their minds throughout their growing years. Environment shapes us, and to get more young women into this field, I think uplifting the entire engineering image in Singapore and Asia is important. Showing young women that engineering is an extremely interesting and rewarding career is important. I think that starts from engaging girls early on, hence partnerships with educational institutions are essential to the entire effort to uplift the branding of engineering as it is a key occupation that contributes to sustainable development.

Globally, there is a skills shortage for engineers. Also, the type of engineering graduates does not always match the type of engineers required by specific countries or industries, according to studies by the Royal Academy of Engineering. This is compounded by the fact that many engineering graduates opt to work in disciplines other than engineering, shrinking the pool of available engineers.

Finding the solution to the skills shortage will not be easy nor quick and will require a coordinated effort by all stakeholders.

The World Engineering Day for Sustainable Development in March annually, for example, offers an occasion for governments, industries, non-governmental organisations and the public at large to connect and address the need for engineering capacity and the quality of engineers to solve the world's most pressing problems. Reports continue to show that there continues to be a shortage of engineers in terms of employability and retention of talents within the engineering sector and companies.

So really, there's no better time than now to step into this career if sustainable impact is what we are after!

What has it been like working at Hexagon?
Hexagon has given equal opportunities to both men and women. Despite the engineering industry being predominantly male, Hexagon has identified my talents and passion for the precision engineering industry and given me the opportunity to learn and grow with the family.

What do we need to do to break the bias? How far do we have to go to change the perception that engineering is a man's world?
When more women in engineering start stepping up and showing the world what they are capable of, this perception will start to change, and the respect for women in the field will grow.

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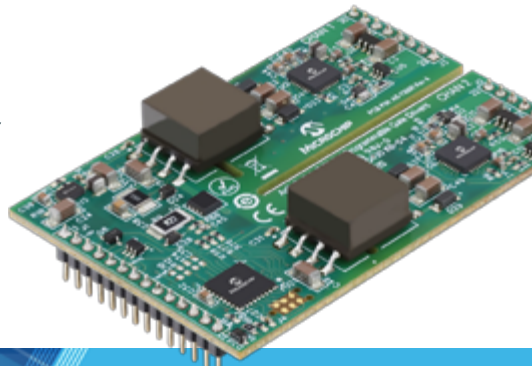

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Measuring Temperature Swing with Optical Fibers during Power Cycling of Power Components

Power semiconductor components play an important role in the power electronics field and their reliability and lifetime have been attracting more and more attention recently. The power cycling test method has been widely used to accelerate the degradation of the device and evaluate its reliability and lifetime. This article presents a power cycling setup based on optical fibers to measure the power module's chips junction temperature during operation under different loading conditions.

By Kaichen Zhang and Francesco Iannuzzo, Department of Energy, Aalborg University

The testbench

has been used to conduct both the DC- and AC- power cycling tests and the junction temperatures acquired by the optical fibers can help to evaluate the thermal stress during the operation, indicate the health status of the device under test (DUT), and built the relevant lifetime model.

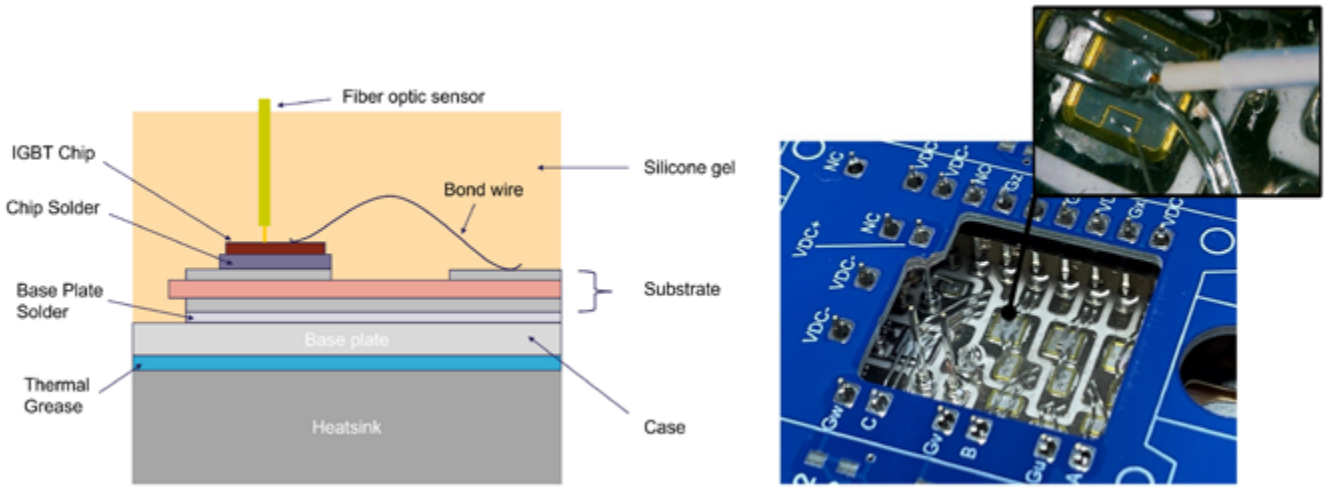
Introduction

Reliability issues of the power semiconductor components have been highly stressed in many applications such as renewable energy and traction. More knowledge about the expected lifetime of the device is demanded, [1]. For designers, to choose the proper power modules applied for realizing the specific mission profiles, relevant reliability investigation is necessary for the early development stage. For device manufacturers, a deep understanding of the power semiconductor component's lifetime and failure modes can help to evaluate and improve in the aspect of packaging materials and designs [2] - [6].

The lifetime prediction methods generally consist of two categories. The first one is based on physics-of-failure (PoF) lifetime models, which are limited due to the lack of detailed information on the materials and geometries of the power modules. Another one is the analytical models, the many use of the rain-flow counting methods, etc, which all need experimental power cycling tests [7] - [9].

Power cycling test in power semiconductor devices generates repetitive thermal-mechanical stresses, which will bring accumulated fatigue and accelerate the aging of the device till the end of life. Among other failure indicators, the junction temperature is one of the most strongly focused. One of the most critical bottlenecks of power cycling test is that junction temperature can derived by Vce,on (Vds,on) during DC power cycling, as the off time can be used to inject a monitoring current and measure the on-state voltage at low current this way, i.e., making effects of degradation such as bond-wire degradation, negligible. However, in the case of modern AC power cycling, this is not possible as injecting a measurement current requires additional circuitry able to disconnect the IGBT / MOSFET from the circuit, thus introducing measurement artifacts, such as stray inductance and resistance [4].

Normally, it has been believed that direct access to the chips to measure the junction temperature can be difficult due to the limit of the module packaging and the dielectric gel [8], even though the optical fibers can be a valid alternative for measuring the Tj in a non-invasive and isolated manner, especially under the case (AC power cycling) when the traditional TSEP (Temperature Sensitive Electrical Parameter) method is not easy to implement. Not until recently, one innovative optical fiber sensing technology is proposed by the OpSense Solutions©, which enables an online junction temperature measurement during the power cycling test. In this article, the details of using the optical fibers to measure the junction temperate under both DC- and ACpower cycling tests are explained, also comes with the experimental results and conclusions.



(a) Scheme of installation of optical fiber in contact to the chip Wto measure temperature.

(b) DUT adapter PCB with optical fiber installed on the power module.

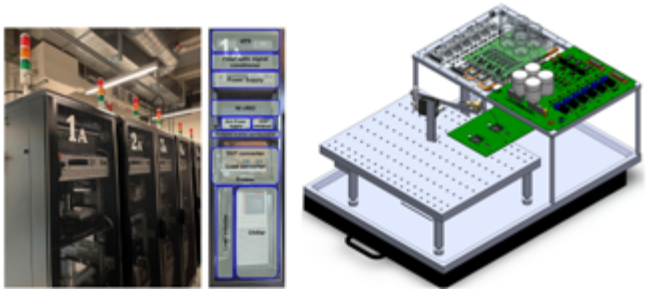
Figure 1: Optical fiber installation.

Fiber Principle

The implementation of optical fiber sensor OTG-PM [10] makes the direct online junction temperature measurement method possible when conducting AC power cycling test. Details of the junction temperature measurement using an optical fiber sensor are described as follows.

Figure 1 depicts the way of using the isolated optical fiber to measure the junction temperatures of one 650V - 20A IGBT module in real-time. One cutout is made on top of the plastic housing of the power module in order to have the sensor able to reach out to the chip surface. As is essential to keep the packaging's insulation property to assure that the converter can run under rated power, voltage, and normal working conditions, the temperature measurement can be challenging. Designed in a way that the miniature sensor head is protected by rigid ceramic tubing, which allows for easy piercing, the OTG-PM sensor can get in touch with the chip surface without removing the silicone gel. Before getting the sensor tip penetrated through the gel, the sensor is prepositioned with the help of fiber holders, and the target zone is determined to be between the two bonding wires in the active area [11].

Except for its ease of mounting on the gel-filled power module, the sensor's fast response time feature (few ms), wide operating temperature range (-40 °C - 250 °C), immunity to EM and RF interference, etc, all makes it well suited for in-situ junction temperature measurement during power cycling test.



(l) 6-unit, 19" industrial rack array with detailed configuration.
(r) Three-dimensional mechanical layout of the developed test bench.
Figure 2: Power cycling setup at AAU Energy, Aalborg University.

Case Study

The test setup shown in Figure 2 is designed to perform power-cycling tests on several kinds of samples and under different conditions, including varied junction temperature swings. As shown in Figure 3, two 3-phase converters are back-to-back connected in order to circulate power. A load converter is used to regulate the current through the inductor at the wanted amplitude and phase.

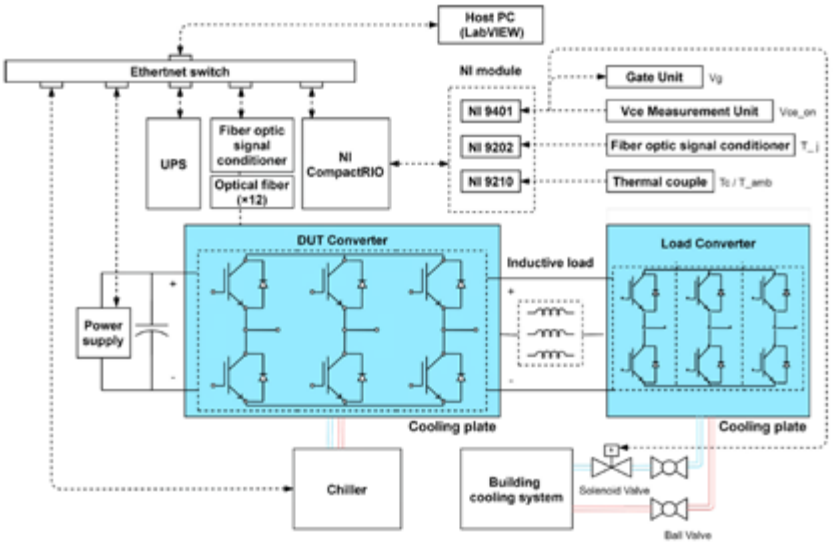


Figure 3: Schematic of the power cycling setup.

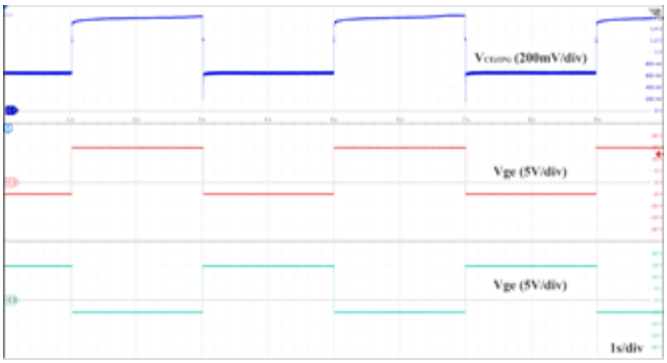
Large space around the DUT converter is saved for optical fiber holder placement. Both DC- and AC- power cycling test can be conducted on this setup, and the experimental test results are shown below:

A. DC Power Cycling

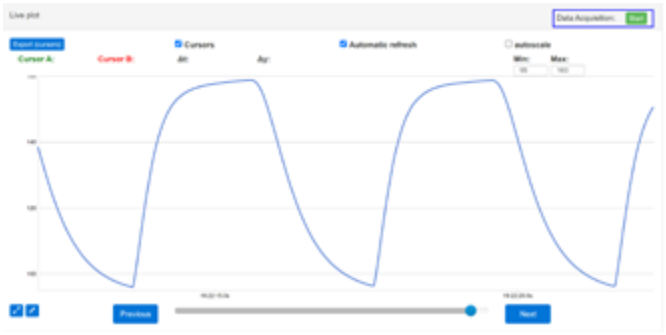
The DC power cycling is conducted with a load current of 20A, 2s on/off time, current is commutating between two phases of the power module. A diagram of the on-state voltage and gate voltage measurement results and a diagram of Tj vs time are reported in Figure 4.

B. AC Power Cycling

The AC power cycling is conducted under 400V dc-link voltage, with a AC peak current of 20A (fundamental frequency of 0.25 Hz). The corresponding junction temperature measurement result is shown in Figure 5, with a temperature swing of 80°C.

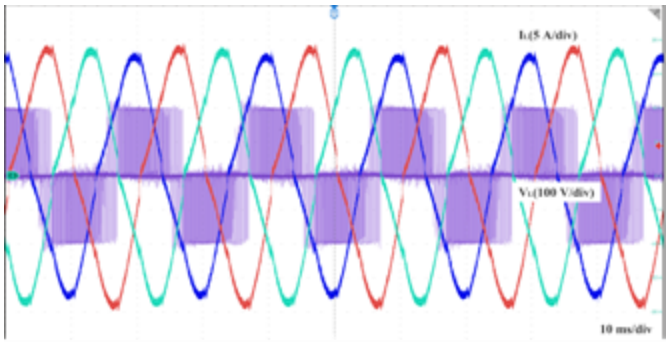


(a) On-state voltage and gate voltage measurement results.

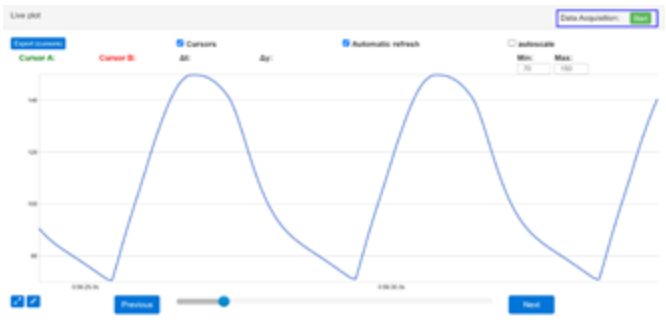


b) Junction temperature measurement result.

Figure 4: DC power-cycling test waveform.



(a) Load current and voltage measurement results.



b) Junction temperature measurement result.

Figure 5: AC power-cycling test waveform.

Conclusion

This article demonstrates that implementing the OpSens optical fiber sensors on the DUT can be one effective and practical way of measuring the junction temperature in power cycling tests (especially for AC-). The results reveal that a stable and accurate measurement result can be achieved without influencing the converter's normal operation. In the final article, more details of the optical fiber implementation and lifetime estimation using junction temperature data will be provided.

Acknowledgment

This work is funded by the X-POWER project from Danish Agency for Science and Higher Education. The authors would like to thank J. Christiansen, M. Lund, B. B. Jensen for their support in the setup implementation.

References

[1] H. Wang, M. Liserre and F. Blaabjerg, "Toward Reliable Power Electronics: Challenges, Design Tools, and Opportunities," in IEEE Industrial Electronics Magazine, vol. 7, no. 2, pp. 17-26, June 2013.

[2] Schuler, Stefan & Scheuermann, Uwe. (2010). "Impact of Test Control Strategy on Power Cycling Lifetime," in PCIM Europe (Power Conversion Intelligent Motion), pp.355-360, May 2010.

[3] L. R. GopiReddy, L. M. Tolbert and B. Ozpineci, "Power Cycle Testing of Power Switches: A Literature Survey," in IEEE Transactions on Power Electronics, vol. 30, no. 5, pp. 2465-2473, May 2015.

[4] Choi, Ui-Min & Blaabjerg, F. & Jorgensen, Soren. (2017). Power Cycling Test Methods for Reliability Assessment of Power Device Modules in Respect to Temperature Stress. IEEE Transactions on Power Electronics. PP. 1-1. 10.1109/TPEL, May 2017.

[5] IEC standard 60749-34:2010 "Semiconductor devices -Mechanical and climatic test methods - Part 34: Power cycling"

[6] Automotive Electronic Council. AEC-Q101-Rev-E; 2021.

[7] S. Kitzler, J. St¨ockl, F. Kupzog and Z. Miletic, "Tracking of Aging Processes in Power Electronic Converters Using the Rainflow Method," IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society, 2018.

[8] N. Baker, M. Liserre, L. Dupont and Y. Avenas,"Improved Reliability of Power Modules: A Review of Online Junction Temperature Measurement Methods," in IEEE Industrial Electronics Magazine, vol. 8, no. 3, pp. 17-27, Sept. 2014.

[9] Y. Zhang, H. Wang, Z. Wang, Y. Yang and F. Blaabjerg, "Impact of lifetime model selections on the reliability prediction of IGBT modules in modular multilevel converters," 2017 IEEE Energy Conversion Congress and Exposition (ECCE), 2017.

[10] Opsens Solutions Inc. OTG-PM Fiber Optic Temperature Sensor datasheet.(2022). [Online]. Available:https://opsenssolutions. com/wp-content/uploads/sites/4/2022/03/IMP0222-OTG-PM-Rev1.0-Preliminary.pdf.

[11] M.Piton, B.Chauchat, J.F.Servi`ere, "Implementation of direct Chip junction temperature measurement in high power IGBT module in operation — Railway traction converter." Microelectronics Reliability, 2018

ECCE 2022

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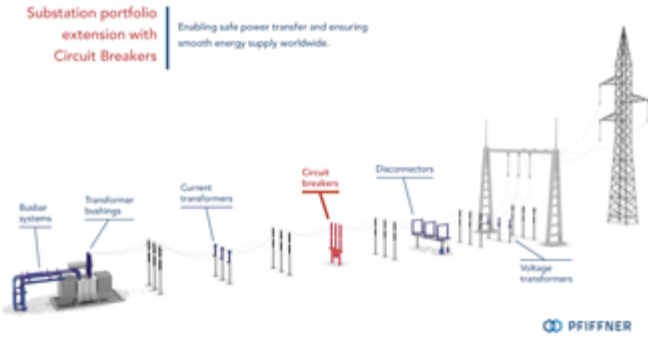
High Voltage Circuit Breaker with Eco-compatible Arc Interruption Method

PFIFFNER Group has announced a high voltage air-insulated switchgear (AIS) circuit breaker for substations which uses an SF6-free and F-gas free as its insulation media for the safe and sustainable operation of electrical grids. Sulfur hexafluoride, commonly known as SF6, is a man-made gas utilized primarily as an electrical insulator and arc suppressant. While extremely effective in circuit breaker applications, it is also one of the most harmful greenhouse gases in existence. As such, component manufacturers in the electrical grid sector have been seeking solutions in recent years to limit its usage. PFIFFNER's solution instead uses an eco-compatible gas that eliminates the use of SF6 and F-gases entirely. Circuit breakers are one of the most critical components in an AIS switchyard. Reliability is crucial, as the product has to work under all conditions, and may spend many years or decades at a time dormant before being required to spring into action. When closed, the circuit breaker must behave like an ideal conductor with no resistance, and when open it must be a perfect insulator, conducting nothing. When the contacts separate upon activation, the interrupter must move instantly to extinguish any arcing and prevent damage to downstream line components. When activated this process will typically occur within 20 to 30 milliseconds, involving the high-speed movement of mechanical masses up to 20-30 kg.



www.pfiffner-group.com

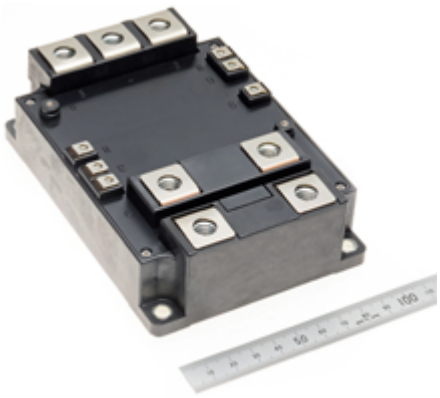
Embedded Control Module for Electric Power Grid Automation

With complex requirements and typically low quantity manufacturing, rack-and-stack approaches have long dominated controls designs for high power electronics. While custom designs might be technically superior, allowing tailored features and compact integration, they often come with prohibitive engineering and manufacturing costs and schedules. Now it is possible to design controls electronics using sophisticated system-on-chip (SOC) and system-in-package (SIP) components to achieve custom results within a manageable design project. The Innova SCM21001 system-on-module (SOM) from Silicon Power Corporation was developed as an embedded computing platform specifically for electric grid automation applications. A dual core DSP SOC and directly connected FPGA are assembled as an independent real time processor subsystem. On the same module, an Octavo Systems embedded Linux computer SIP supports management of the real time processor and provides modern communication protocols for connection to external systems, all using readily available open-source software. The SOM serves as a control system component, allowing tight integration with application specific components such as power, analog sensor conversion, and actuator drives. A conduction cooled form factor supports deeply embedded, high reliability applications. The design was fully functional with the first prototype, so system development proceeded with no controls design delays. As a component or as a reference design, the SOM demonstrates that custom controls design is once again a viable option for power electronics.

www.siliconpower.com

IGBT Module Will Reduce Size and Power Consumption of DC1500V Converters

Mitsubishi Electric Corporation announced that it will begin shipping samples of its LV100-type T-series 2.0kV insulated-gate bipolar transistor (IGBT) Module for industrial use. The power-semiconductor product is expected to downsize and reduce the power consumption of power-conversion equipment for use with renewable-energy sources. Power semiconductors for efficiently converting electric power are being increasingly utilized as key devices that can help to lower the carbon footprint of global society. At the same time, efficient power conversion through the deployment of increasingly higher system-operating voltages is being demanded for power grids that use renewable-energy power sources, which has led to the development of power converters rated at DC1500V, the upper limit of the EU's Low Voltage Directive.



Module samples that Mitsubishi Electric will start shipping soon have a blocking-voltage capability of 2.0kV, which is suitable for DC1500V power conversion equipment used mainly for large-capacity systems of several hundred kW to several MW, including renewable-energy power sources. Adopting 2.0kV withstand voltage semiconductors will enable customers to simplify the design of their DC1500V power-conversion equipment. Also, the latest 7th-generation IGBT and Relaxed Field of Cathode (RFC) diode will help to downsize and reduce the power consumption of power-conversion equipment for renewable-energy power supply. In addition, the module's industrial LV100-type package, which is suitable for large-capacity systems due to its easy-paralleling configuration, will help to simplify large-capacity system designs.

www.mitsubishielectric.com

TOLL-packaged 650 V Silicon Carbide MOSFET

onsemi announced a TO-Leadless (TOLL) packaged sillicon carbide (SiC) MOSFET. The transistor addresses the rapidly growing need for high-performance switching devices that are suitable for designs with high levels of power density. Until recently, SiC devices had been supplied in D2PAK 7-lead packages which required significantly more space.

With a footprint of just 9.90 mm x 11.68 mm, the TOLL package offers 30% savings in PCB area over a D2PAK package. And at a profile of just 2.30 mm, it occupies 60% less volume than a D2PAK package. In addition to its smaller size, the TOLL package offers better thermal performance and lower package inductance (2 nH) than a D2PAK 7-lead. Its Kelvin source configuration ensures lower gate noise and lower switching losses – including a 60% reduction in turn-on loss (EON) when compared to a device without a Kelvin configuration, ensuring significant improvements in efficiency and power density in challenging power designs as well as improved EMI and easier PCB design.

The first SiC MOSFET to be offered in the TOLL package is the NTBL045N065SC1 which is intended for demanding applications including switch-mode power supplies (SMPS), server and telecommunication power supplies, solar inverters, uninterruptible power supplies (UPS) and energy storage. The device is suitable for designs that are required to meet the most challenging efficiency standards including ErP and 80 PLUS Titanium. The NTBL045N065SC1 has a VDSS rating of 650 V with a typical RDS(on) of just 33 mΩ and a maximum drain current (ID) of 73 A. Based upon wide bandgap (WBG) SiC technology, the device has a maximum operating temperature of 175°C and ultra-low gate charge (QG(tot) = 105 nC) that significantly reduces switching losses.

www.onsemi.com

Collaboration on Power Module to Accelerate Silicon Carbide Adoption

NXP® Semiconductors has announced a collaboration with Hitachi Energy to accelerate the adoption of silicon carbide (SiC) power semiconductor modules in e-mobility. The project aims to provide SiC MOSFET-based solutions for powertrain inverters comprised of NXPs GD3160 isolated HV Gate Drivers and Hitachi Energy's RoadPak automotive SiC MOSFET power modules.

Hitachi Energy's high-performance automotive power semiconductor module RoadPak delivers excellent heat dissipation, low stray inductances, and long-term ruggedness to withstand the challenging automotive environment; a key to unleashing the full capabilities and benefits of SiC MOSFETs. To attain optimal performance, the power module is paired with NXP's GD3160 high-voltage, isolated gate driver which enables fast and reliable switching and fault protection.

"Working with Hitachi Energy has allowed us to highlight the efficiency and range benefits of SiC MOSFETs for e-mobility. By pairing the GD3160 with the Hitachi Energy's RoadPak SiC module, we've delivered a solution that aims to reduce the transition time from evaluation to performance optimization of SiC MOSFETs used in traction inverters." Said Robert Li, Vice President and General Manager of NXP's Drivers & Energy Systems Product Line. Hitachi Energy has been leveraging its technology and the experience gained in the industrial and transportation segments to develop its high-density RoadPak automotive SiC power modules for e-mobility applications. The RoadPak half-bridge power module incorporates 1200V SiC MOSFETs, integrated cooling pin-fins and low inductance connections all in a small form factor. It can support applications from e-buses and electric passenger vehicles to high-performance Formula-E race cars.

www.nxp.com

Low Insertion Impedance Method of Measuring Alternating Currents

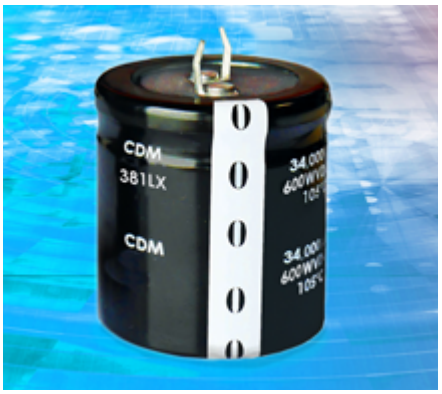
PEM's CWT 'HF' family of Rogowski current probes meet the challenges of measuring current in renewable and power electronic applications with attenuate interference from fast local voltage transients and retain a small size. They also feature optimised high frequency (HF) performance to measure rapidly changing AC currents. The CWTMini50HF is available with a coil size of just 100mm, 3.5mm thick with a rise-time capability of 12.5ns, ideal for the challenging environment of converters utilising power SiC semiconductor switches. At the other end of the scale, the CWTHF with coils from 300mm to 1000mm, or even longer, enable measurement in applications as diverse as high frequency bearing current in machine shafts, lightning strikes and pulsed power applications and power measurement in large motor drives.

www.pemuk.com

Snap-in Aluminum Electrolytic Capacitor

Cornell Dubilier Electronics announced that it has expanded its signature series of 380LX and 381LX aluminum electrolytic capacitors to include voltages up to 600 Vdc. The ratings are designed to serve the company's industrial electronics customers who continue to push the application boundaries for these components into higher voltages.

The 380LX and 381LX snap-in series are among the industry's top performers with a published load life of 3,000 hrs. when tested at rated voltage and ripple current at rated temperature. The 380LX series is designed for 85 °C operation, while the 381LX series meets the same load life at 105 °C. These components demonstrate exceptional life in real-life applications where conditions



are typically lower than the capacitor's maximum specified ratings. Newly added capacitance values in the range of 150 µF to 330 µF are offered at 550 and 600 Vdc in the 380 LX series and 140 µF to 340 µF at 500, 550, and 600 Vdc in the 381LX series. Developed at CDE's technology center in Liberty, SC, these new ratings are offered with enhanced ripple current capability, up to 3.7A at full-rated conditions. The company's latest advances in electrolyte development, materials, and processing technology make their higher voltage ratings and excellent performance possible.

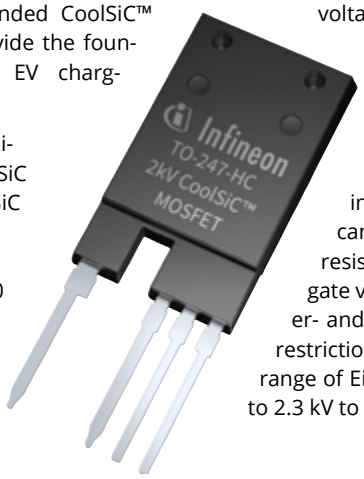
The company expects these higher voltage snap-in capacitors to be used in the latest inverter circuits for renewable energy, UPS systems, battery chargers, motor drives, welders, and other applications that require the highest performance components to improve system reliability.

www.cde.com

2 kV Silicon Carbide MOSFETs for 1500 VDC Applications

Infineon Technologies introduced its expanded CoolSiC™ portfolio with high-voltage solutions to provide the foundation for next-generation photovoltaic, EV charging and energy storage systems.

The extended CoolSiC portfolio offers 2 kV silicon carbide (SiC) MOSFETs, along with a 2kV SiC diode for applications up to 1500 V DC. The SiC MOSFET combines both low-switching losses and high-blocking voltage in one device that can optimally meet the requirements of 1500 V DC systems. The 2 kV CoolSiC technology offers a low drain-source on resistance (R DS(on)) value. In addition, the rugged body diode is suitable for hard switching. The technology enables sufficient over-



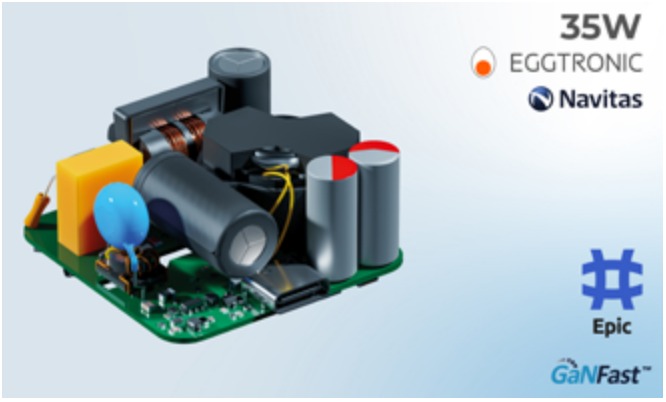
voltage margin and offers ten times lower FIT rate caused by cosmic ray, compared to 1700 V SiC MOSFETs. Furthermore, the extended gate voltage operating range makes the devices easy to use.

This SiC MOSFET chip is based on Infineon's SiC MOSFET technology named M1H which has recently been introduced. The latest advancements enable a significantly larger gate voltage window that improves the on-resistance for a given die size. Simultaneously, the larger gate voltage window provides a high robustness against driver- and layout-related voltage peaks at the gate, without any restrictions even at high switching frequencies. Infineon offers a range of EiceDRIVER™ gate drivers with functional isolation of up to 2.3 kV to support the 2 kV SiC MOSFETs.

www.infineon.com

Platform for Developing GaN-Based Zero Voltage Switching Chargers

Eggtronic and Navitas have announced a QuarEgg evaluation board that will speed the development and implementation of fast-chargers and power adapters. QuarEgg is an proprietary Zero Voltage Switching power architecture that has been designed to improve the efficiency and reduce the size of AC/DC converters. The architecture maximizes the performance, minimizes the form factor and improves the reliability of AC/DC power schemes in applications ranging from USB-C Power Delivery fast chargers and adapters for mobile devices and laptops to power supplies for loudspeakers and



smart home assistants. The 35W AC/DC evaluation board brings together the QuarEgg ZVS architecture integrated in an Eggtronic EPIC101AFQE01 secondary side mixed-signal controller embedding USB Power Delivery 3.1, Synchronous Rectification, no-opto control of primary side FET, and Navitas' GaN technology. Compared to conventional silicon-based designs built using active clamp flyback (ACF) or quasi-resonant (QR) topologies, this combination offers improved AC/DC conversion performance and efficiency and much smaller product form factors. In addition, when compared to the silicon counterpart based on the same QuarEgg controller, GaN offers a further 8% energy savings.

The AC/DC development board measures just 38.3 x 38.3 x 18.55 mm and incorporates all of the components needed for a USB-PD or fixed-output converter Peak efficiency is in excess of 94.1%, while a very flat efficiency curve ensures maximum efficiency and minimum power losses across the widest possible range of loads. This includes a 91% efficiency when in light load conditions (10% of maximum load), which is fundamental for devices that are always plugged in and draining power from the mains.

www.eggtronic.com

Integrated Current Sensor with Sigma Delta Bitstream Output

LEM announced the launch of HMSR DA, an Integrated Current Sensor to offer a Sigma Delta bitstream output which provides significant benefits when used in applications that are prone to noise, distortion and interference. It has been designed to provide a solution to industries requiring clean signals and facing significant problems in case of vibrations, electric noise and electromagnetic noise, for example.

Specific advantages of an Integrated Current Sensor with digital output include superior signal share and reduced noise as well as lower cost and a smaller mechanical footprint. HMSR DA will replace much more complex and costly alternative systems that would traditionally include a shunt resistor, a digital insulator and a power supply circuit. Having all these features incorporated into a single unit makes the HMSR DA a far more attractive option for applications where space is at a premium and minimal cost is essential.

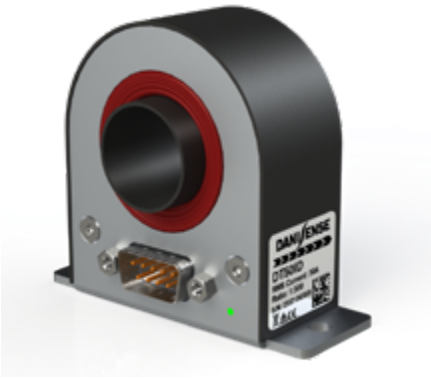
Typical applications for the digital output unit include standalone servo drives, robotics, sewing machines, automated guided vehicles (AGVs), CNC machine tools and a range of other applications that demand high resolution output. The HMSR DA sensor, which offers resolution of 11 to 13 bits and features a 10MHz clock, is LEM's first step toward building a digital Integrated Current Sensor roadmap. The company is already working on the next generation of digital Integrated Circuit Sensors which will offer a resolution of 14 to 16 bits and a clock operating above 20MHz.

www.lem.com

Isolated DC and AC Current Measurement up to 200Arms

Danisense is launching its DT series of fluxgate technology current transducers for isolated DC and AC current measurement up to 200Arms. Benefiting from a considerable reduced size with 60% less volume compared with the previous product generation, the devices feature a large frequency bandwidth of up to 2MHz and a primary current of ranging from 50A up to 200A.

DT series current transducers use Danisense's Fluxgate, closed loop compensated technology with fixed excitation frequency and second harmonic zero flux detection for best in class accuracy and stability. Excellent linearity (better than 2 ppm), an industry standard DSUB 9-pin connection, a green diode for normal operation indication and a large aperture with a diameter of 20.7mm for cables and bus bars are further features of the components. DT series current transducers are Ideal for applications such as high precision power supplies for laboratories, accelerators and medical equipment where size is a key factor as designs for such power supplies are getting smaller and smaller to increase power density and reduce costs. Size is also very important for the embedded power measurement application for cars where placing the transducers in a compact motor and inverters environment is always a challenge. The large frequency bandwidth of the DT series is another advantage for such power measurement applications.

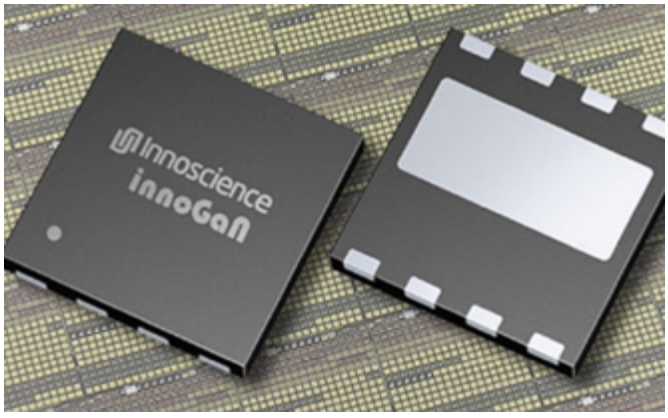


www.danisense.com

65 W Active Clamp Flyback Reference Design with 30 W/in^3 Power Density

Innoscience and Silanna Semiconductor demo'd a 65 W Active Clamp Flyback (AFC) reference design with 30 W/in^3 uncased power density. The design achieves efficiency levels of greater than 94% @ 230 Vac and has a no-load power consumption of less than 25 mW.

The design combines the performance of Innoscience's INN650D240A 650V GaN-on-silicon enhancement-mode power transistor with Silanna's SZ1131 Fully Integrated Active Clamp Flyback (ACF) controller. The GaN HEMT enables ultra-high switching frequency, has no reverse-recovery charge and low gate charge and low output charge. RDS(on),max is 240 mΩ. Silanna's CO2 Smart Power™ SZ1131 combines high integration and operational efficiency (95%) with no-load power consumption of under 20mW. The 65 W reference design on a PCBA measuring just 34 x 34.5 x30.5mm. It has an input voltage range of 90-265 VAC and offers USB-PD output voltages and current configurations of 5 V/3 A, 9 V/3 A, 15 V/3 A and 20 V/3.25 A. Innoscience and Silanna Semiconductor are also collaborating on higher power multi-port reference designs and will introduce them to the market soon. SZ1131, the latest addition to Silanna's family of CO2 Smart Power™ technologies,

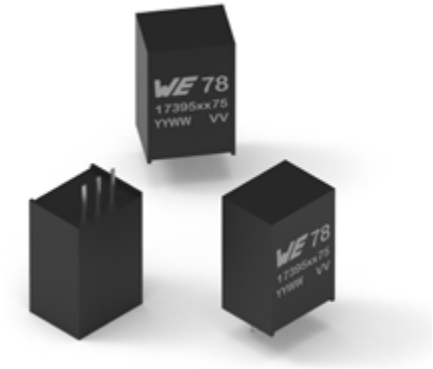


addresses the power management challenge facing engineers by simplifying design and improving performance while meeting environmental sustainability goals through more efficient energy use.

www.innoscience.com

Power Module Suitable for 48 V Industrial Voltage Network

Würth Elektronik extends its MagI³C-FDSM power module product range: The fixed step-down regulator modules now cover all bus voltages from 12 V up to 48 V. The modules facilitate development for applications with direct connection to bus voltages of 12 V, 24 V or 48 V. The wide input voltage range up to 74.5 V makes the FDSM module robust against voltage transients on the 48 V bus. The new power modules are implemented in a cost-effective SIP-3 package and provide fixed output voltages of 3.3 V, 5.0 V as well as 12 V, with an output current up to 0.5 A.



The MagI³C-FDSM series are fully integrated DC/DC voltage converters with fixed output voltage. Besides the power stage, the modules consist of a regulator, inductor as well as input and output capacitors. The power modules are protected against short circuit and thermal overload. MagI³C-FDSM reduces the workload involved in circuit design to a minimum, as no external components are required for operation—this reduces development costs and time. For simple assembly, the MagI³C-FDSM family has been realized in a standard THT housing. Pre-compliance testing of our evaluation board has shown the conducted and radiated EMI is below limits established by relevant standards.

www.we-online.com

Clip-bonded FlatPower Packaged Diodes

Nexperia announced the release of 14 rectifiers for power applications in its CFP2-HP (Clip-Bonded FlatPower) packaging. Available in standard and AEC-Q101 versions, these include 45 V, 60 V and 100 V Trench Schottky rectifiers (with 1 and 2 A options) including the PMEG100T20ELXD-Q, a 100 V, 2 A Trench Schottky barrier rectifier. For applications requiring hyperfast recovery Nexperia has also added the 200 V, 1 A PNE20010EXD-Q rectifier to the portfolio.

The vertical thermal design on multilayer PCBs enables designers to save up to 75% of board space with CFP2-HP compared to using a device in a SMA package, while still maintaining the same level of electrical performance. This rugged package design enables longer operating times and better board level reliability, while the new lead shape improves automatic optical inspection (AOI).

"With the switch to smaller packages like CFP being now well underway, Nexperia is aiming to be the driving force that further accelerates this transition" according to Frank Matschullat, Product Group Manager Power Bipolar Discretes at Nexperia. "Nexperia has invested heavily to expand its capacity to serve the growing demand for CFP-packaged products stays well ahead of market projections for the next three years. These diodes are the latest additions to over 240 CFP-packaged products which Nexperia currently offers."

Today, CFP packaging is used by different power diode technologies such as Nexperia's Schottky, silicon germanium and recovery rectifiers but can also be extended to bipolar transistors. It offers significant product diversity, covering single/dual configuration and currents between 1-20 A, simplifying board design.

www.nexperia.coml

Material Solutions for e-Mobility

Indium Corporation® is announcing a line of material solutions for e-Mobility. The Rel-ion™ suite of electrical, mechanical, and thermal solutions are designed to be reliable, scalable, and proven materials, reducing electric vehicle (EV) manufacturers› time to market. "We at Indium Corporation have created a suite of products under the Rel-ion™ banner that must meet three very important criteria," said Brian O'Leary, global head of e-Mobility and infrastructure. "First—they're reliable. They are designed to meet the higher quality standards that meet the higher demands of automotive electrification. Second—they're scalable. They are readily available and capable of meeting supply chain expectations. Finally—they're proven. Most of Indium Corporation's Rel-ion™ products have more than a decade of running inside of EVs. Our customers have confidence that the product will work, confidence that they can get enough of it to meet demand, and the peace of mind that comes with using proven material solutions."

Indium Corporation has also expanded its free InSIDER Series of webinars to include the "Driving e-Mobility: Rel-ion™ Technical Webinars". This series features global industry technical experts in advanced materials and the automotive market with all sessions

moderated by O'Leary. This series of webinars is intended specifically for those involved in the field of e-Mobility, whether new to the industry or with several years of experience as the EV industry undergoes rapid growth and evolution.

www.indium.com

SiC FETs for 800V Architectures

Qorvo announced a series of 1200V Silicon Carbide (SiC) Field Effect Transistors (FETs). The UF4C/SC series of 1200V Gen 4 SiC FETs are ideally suited for mainstream 800V bus architectures in onboard chargers for electric vehicles, industrial battery chargers, industrial power supplies, DC/DC solar inverters, as well as welding machines, uninterruptible power supplies, and induction heating applications.

Anup Bhalla, Chief Engineer – Power Devices, UnitedSiC/Qorvo, said: "Expanding our 1200V range with higher performance Gen4 options allows us to better serve the engineers who are moving their bus designs to 800V. In electric vehicles, this move to higher voltages is inevitable and these new devices, with four different RDS(on) classes, help designers select the best possible SiC choice for every design."

All RDS(on) options (23, 30, 53 and 70 milliohm) are offered in the industry standard 4-lead kelvin source TO-247 package, providing cleaner switching at higher performance levels. The 53 and 70 milliohm devices are also available in the TO-247 3-lead package. This series of parts have excellent reliability, based on the well-managed thermal performance, which is a result of an advanced silver-sinter die attach and advanced wafer-thinning process.

All 1200V SiC FETs are included in FET-Jet Calculator™, a free online design tool that allows for instant evaluation of efficiency, component losses, and junction temperature rise of devices used in a wide variety of AC/DC and isolated/non-isolated DC/DC converter topologies. Single and paralleled devices may be compared under user-specified heat-sinking conditions to enable optimum solutions.

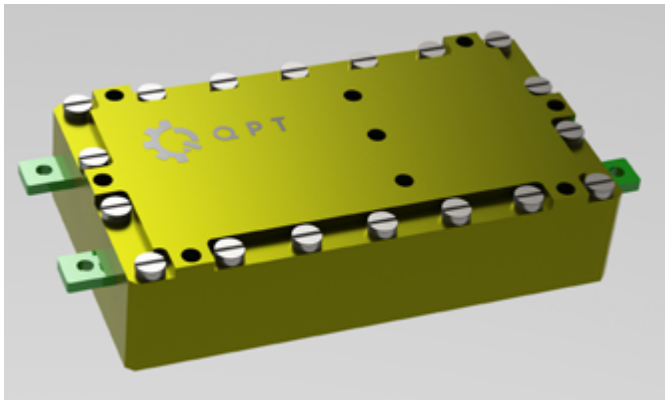
www.unitedsic.com

Drive Module for HVAC Motors

Quantum Power Transformation (QPT) announced the launch of its qGaNDriveTM Module to unleash the full performance potential of Gallium Nitride (GaN) power transistors in motor drives for HVAC heating, ventilation, and air conditioning systems. Commenting on the news, QPT Founder Rob Gwynne said, "GaN transistors have always promised the best performance and efficiency over Silicon MOSFETs and Silicon Carbide, but they are notoriously difficult to drive at speed. We have developed an entirely new and unique topology for driving GaN transistors allowing them to switch at speeds of up to 20MHz, delivering major benefits in power consumption and efficiency."

Business Development Manager Richard Ord went on to add: "Electric motor driven systems (EMDS) consume 45% of the world's energy, and yet their efficiency at typical operating speeds can be as low as 50%. Our solution tackles performance across the range of operating speeds and could improve efficiency by up to 35%."

The challenge of driving Gallium Nitride transistors has so far restricted broader adoption and compromised performance: QPT's solution fixes that problem and will accelerate GaN market share.



The qGaNDriveTM Module from QPT integrates their core topology with GaN transistors in a fully EMC-screened turn-key power module. The company estimates that a typical 15kW domestic heat pump could deliver a return in energy savings in one hundred days or less.

www.q-p-t.com

2W Medical Grade DC/DC Converter

For the ever increasing demand for medical home care and medical equipment P-DUKE has extended its medical power conversion portfolio with a MPL02 board-mount DC/DC converter series. The MPL02 series is designed especially for compact medical applications and comes in a tiny SIP-8 industrial standard package (footprint only 9.9 x 21.8 mm) which saves space on the PCB. It offers 5000Vac isolation voltage, reinforced insulation of 2xMOPP (patient protection) / 250Vac working voltage with 8 mm clearance and creepage distance between input and output. The series delivers up to 2W output power and offers regulated single and dual outputs with a wide 2:1 input range of 4.5-13.2, 9-18 and 18-36V. It provides full-protection functions such as: over-current, short-circuit, under-voltage lockout as well as low 2µA leakage current. These are the main factors which assure a safe environment for operators and patients. The series also comes with a 5-year product warranty. The MPL02 series has been certificated to IEC/EN/ANSI/AAMI ES60601-1, IEC/EN/UL 62368-1 and MIL-STD 810F standards. With its compact casing, low 2µA leakage current and all the safety certifications makes this series the perfect choice for a variety of medical equipment such as; oxygen and heart rate monitors, brainwave monitors and oral caring equipment.

www.pduke.com

IGBT/SiC Module Driver Family Targets Bus, Truck and Con-Ag EVs FETs for 800V Architectures

Power Integrations announced the SCALETM EV family of gate-driver boards for Infineon EconoDUALTM modules. Suitable for original, clone and new SiC variants, the driver targets high-power automotive and traction inverters for EV, hybrid and fuel-cell vehicles including buses and trucks as well as construction, mining and agricultural equipment.

SCALE EV board-level gate drivers incorporate two reinforced gate-drive channels, associated power supplies and monitoring telemetry. The boards are automotive-qualified and ASIL B certified, enabling implementation of ASIL C traction inverter designs. The first SCALE EV family member to be released is the 2SP0215F2Q0C, designed for the EconoDUAL 900 A 1200-volt IGBT half-bridge module.

The high level of integration provided by innovative driver ICs enables the entire driver board, including gate power, to fit onto the outline of the power module, while still providing the spacing necessary for reinforced isolation according to the IEC 60664 standard. The ASIC package provides 11.4 mm of creepage and clearance, specifically designed to meet the requirements for 800volt vehicle system voltages. Input and output lines to the system microcontroller are connected via two independent on-board connectors to meet functional safety requirements. A single 5 V supply per channel is required, with other isolated voltages being generated on the board itself.

The SCALE EV gate-driver family is rated at 1200 V for 400-volt and 800-volt systems and supports both silicon carbide (SiC) MOSFETs and silicon IGBTs.

www.power.com

100 V, 2 mΩ GaN FET for Space-constrained Applications

Efficient Power Conversion Corporation expands the selection of low voltage, off-the-shelf gallium nitride transistors with the introduction of the EPC2071 (1.7 mΩ typical, 100 V) GaN FET.

The EPC2071 is ideal for applications with demanding requirements for high power density performance including 48 V – 54 V input DC-DC for new servers and artificial intelligence. Lower gate charges, QGD, and zero reverse recovery losses enable high-frequency operations of 1 MHz and beyond and high efficiency in a tiny 10.2 mm2 footprint for state-of-the-art power density.

The EPC2071 is ideal for BLDC motor drives, including e-bikes, e-scooter, robots, drones, and power tools. The EPC2071 is 1/3rd the size of a silicon MOSFET with the same RDS(on), QG is 1/4th that of the MOSFET, and the dead time can be reduced from 500 ns to 20 ns to optimize motor plus inverter efficiency and reduce acoustic noise.

The EPC2071 is footprint compatible with EPC's prior Generation 4 family of products: EPC2021, EPC2022, EPC2206. The Generation 5 improvement in Area x RDS(on) gives the EPC2071 the same on-resistance as the prior generation with a 26% smaller size.

"The EPC2071 makes the ideal switch for the primary side of the LLC DC-DC converter from 40 V – 60 V to 12 V- 5V. This 100-volt device offers improved performance and cost compared with previous-generation 100 V GaN FETs allowing designers to economically improve efficiency and power density", according to Alex Lidow, EPC's co-founder and CEO. "These parts are also suitable for telecom and server power supplies, and solar applications."

www.epc-co.com

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SEMI AMERICAS EVENTS

Technology Leadership Series of the Americas Events

The **Technology Leadership Series** of the Americas is a collection of eight major events representing the various technology communities in our industry. These programs connect 2,400+ member companies and over 1.3 million global professionals to advance the technology and business of electronics manufacturing and the design-supply chain.

There are numerous ways for you to participate in these events to connect with the industry and grow your business.

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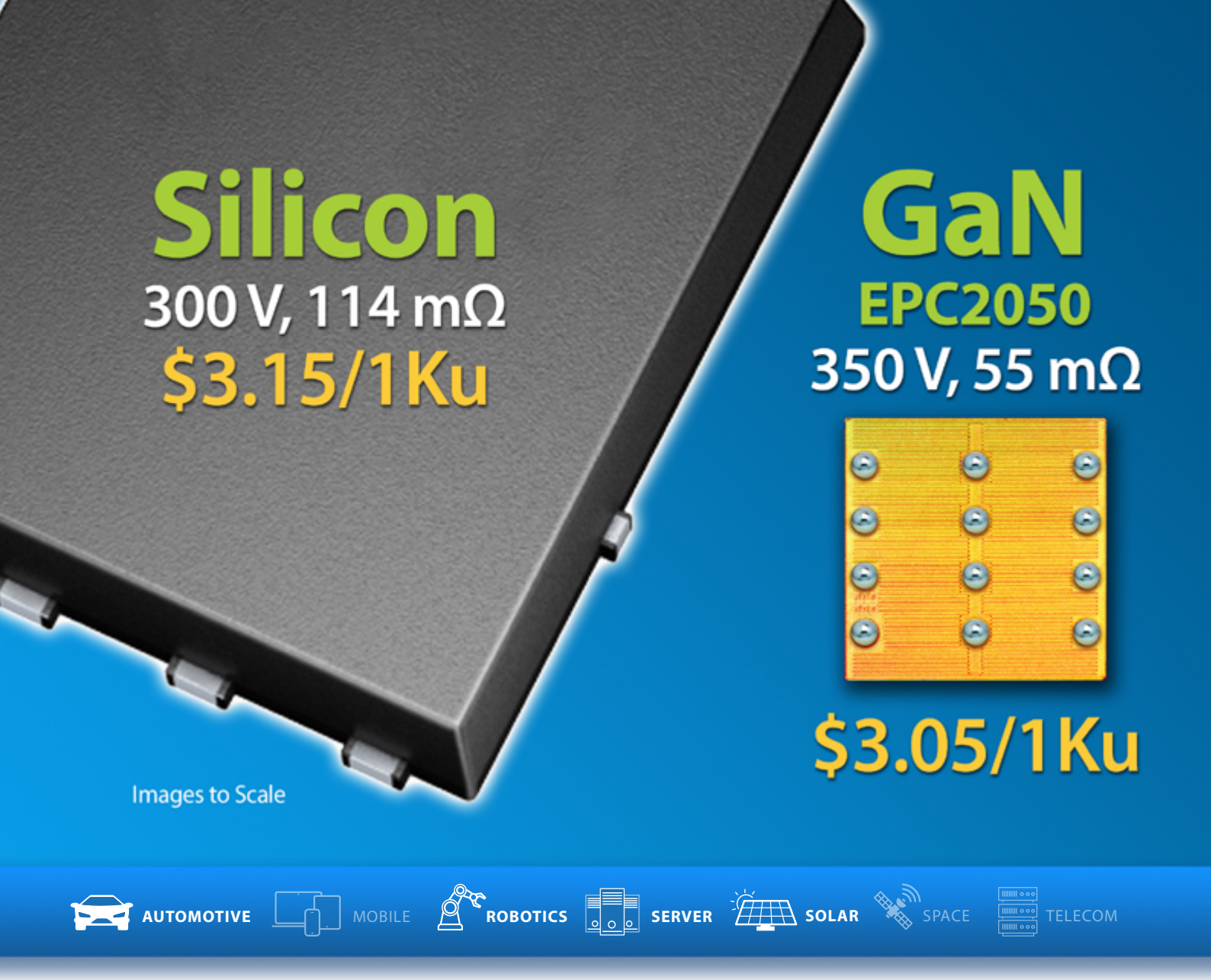

350 V eGaN® FET - 20 Times Smaller Than Comparable Silicon and Lower Cost

Ideal for multi-level converters, EV charging, solar power inverters, lidar, and LED Lighting. eGaN® FETs and ICs are smaller, faster, more reliable, and lower priced…there are no more excuses not to migrate your silicon designs today!

Note:
Scan QR code to learn more.
bit.ly/EPC2050bp

EFFICIENT POWER CONVERSION

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