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Electronics in Motion and Conversion

September 2017

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Free Journalism is a Must

It is a shame that more and more Journalists are threatened with prison for being "politically incorrect". Often, an official accusation is not made. We need to turn away from such countries that are unable to honor human rights and have no democratic structures. The European Union must not support these.

Great Britain has voted for "Brexit" and may face an economic disaster from lower growth rates versus the other European Countries. Those who may criticize a strong economy, such as in Germany, should learn from those that get it right. Any society gets what their people vote for. In the US, Americans have elected a President "To make the country great again", but since then, the US dollar has lost about 20 percent against the Euro. At some point, people will recognize that it is not what they wish – most often too late to cry about.

But we are engineers, and have learned to develop solutions to improve our lives. It is a shame that German automakers misrepresented Diesel emissions - the whole industry knew that diesel engines needed improvement. But now, a new engineering solution is emerging in electro-mobility. History had demonstrated that companies in a great industry can fail by not recognizing new trends and goals. Steam locomotive manufacturing companies did not survive the conversion to diesel or electric. Combustion engine makers cannot hold on to old concepts while newcomers make the change. Tesla is an example of boldly starting the electric vehicle market. Now, the concept is taking hold - an electric delivery scooter fleet is being readied for the German postal service.

Bodo's Power Systems reaches readers across the globe. If you are using any kind of tablet or smart phone, you will find all of our content on the new website www.eepower.com. If you speak the language, or just want to have a look, don't miss our Chinese version: www.bodospowerchina.com

My Green Power Tip for September:
Gooseberries are soon at their best! Eat them while you pick them from the bush. Do not turn them into a smoothie - save the energy of powering a smoothie maker - just pick and eat them, like you did last month with your strawberries.

Keep in mind that Oktoberfest 2017 in Munich Germany is September 16th to October 3rd. Plan your trip ahead of time.

Best Regards

Events

EPE ECCE 2017
Warsaw, Poland, September 11-14
www.epe2017.com

EV Tech Expo 2017
Novi MI, USA, September 12-14
www.evtechexpo.com

HusumWind 2017
Husum, Germany, September 12-15
www.husumwind.com

PCNS 2017
Brno, Czech Republic, September 12-15
www.passive-components.eu/pcns

Semicon Taiwan 2017
Taipei, Taiwan, September 13-15
www.semicontaiwan.org

Power Fortronic 2017
Reggio Emilia, Italy, September 20-21
www.powerfortronic.it

CAVE 2017 Birmingham,
United Kingdom, 25-26 September
http://events.theiet.org/automated-vehicles

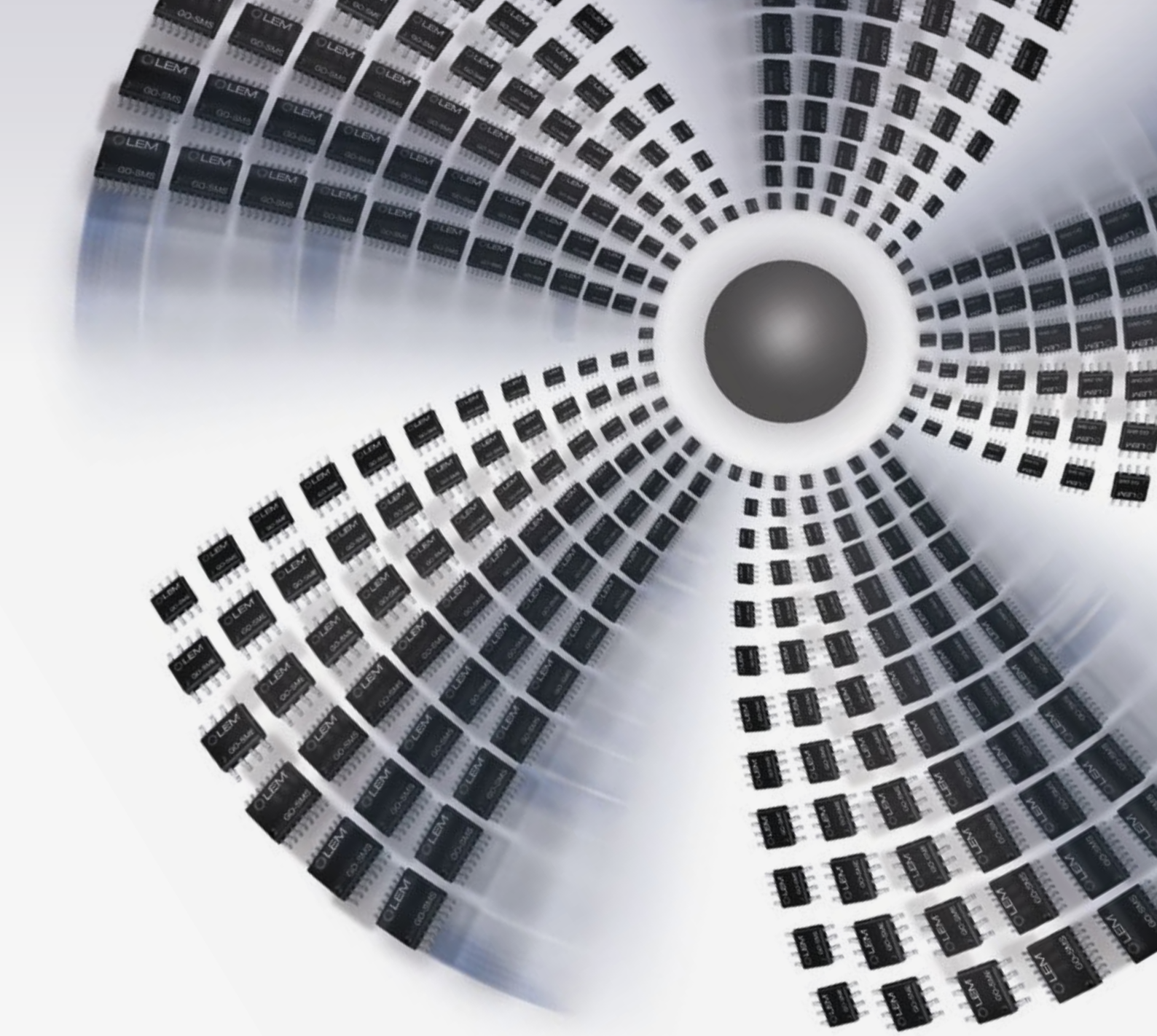
ESREF 2017
Bordeaux, France, September 25-28
http://esref2017.sciencesconf.org

LpS 2017
Bregenz, Austria, September 26-28
www.LpS2017.com

ECCE 2017 Cincinnati OH, USA,
October 1-5
www.ieee-ecce.org/2017

CWIEME Chicago 2017
Chicago IL, USA, October 3-5
www.coilwindingexpo.com/chicago

INTELEC 2017
Gold Coast, Australia, October 22-26,
www.intelec.org



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A unique sensor with an integrated primary conductor achieves optimum temperature accuracy, measuring from -40 to +125 °C in a surface mounted SO8 or SO16 package.

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Special Session at ECCE 2017 on Power

PEIC member, companies from the semiconductor industry, equipment manufacturers, national laboratories, & universities involved in power electronics R&D will discuss key challenges & opportunities. As an integral part of its mission to advance the U.S. power electronics industry's competitiveness in the global economy, the Power Electronics Industry Collaborative (PEIC) has organized a panel discussion to present challenges and opportunities facing the power electronics industry as it seeks to identify, attract, and nurture new engineering talent in the business, academic, and government sectors that comprise and support the U.S. power electronics industry. The panel will be presented as part of the Special Session program at the IEEE Energy Conversion Congress & Expo (ECCE), slated for October 1 – 5, 2017 in Cincinnati, OH.

https://peic-us.org/

http://www.ieee-ecce.org/2017/

Dean Technology Certified to ISO 9001:2015

Achievement of this certification shows DTI's commitment to customer satisfaction, high quality, and continuous improvement. ISO 9001 is a quality management system standard that was developed by the International Organization for Standardization, an association of governmental and nongovernmental organizations from many countries.

The ISO 9001 standard is utilized to certify quality management systems that focus on continuous improvement, customer satisfaction and the active involvement of both management and employees in a process based approach.

"I could not be happier with the performance everyone at DTI has shown throughout the process of achieving ISO 9001:2015 certification," said Craig Dean, CEO of Dean Technology, Inc. "Beyond the hard work, and time required to become certified, this accomplishment shows just how much each employee here cares about the quality of what we do. We will continue to do everything we can to provide the best products and service to all of our customers into the future!"

Dean Technology was certified to the ISO 9001:2015 standard by Performance Review Institute Registrar

www.deantechnology.com/resources/more

Semikron Welcomes Two New Managers

Semikron strengthens its top management team. Christian Eiber, who will be responsible for the automotive business segment, will be joining Semikron as of August 1st, while Karl-Heinz Gaubatz will take over as Chief Technology Officer (CTO) on December 1st of this year.

Christian Eiber previously held a long-term management position at Nemak, where he was in charge of the development of the business segment Aluminium Castings, among others for electric vehicles. Karl-Heinz Gaubatz has extensive international management experience in the business segment Electrics / Electronics at the BMW Group as well as with global automotive supplier Dräxlmaier.

We are delighted to welcome Christian Eiber and Karl-Heinz Gaubatz to the SEMIKRON top management team.

www.semikron.com

PLAT4M Matures Three Silicon Photonic Platforms

Leti announced that the European FP7 project PLAT4M has now been completed with results that exceeded expectations.

Si photonics has long been expected to bring substantial breakthroughs in very high speed data communications, telecommunications and supercomputing. In addition, it is one of the most promising industrial-production candidates because of its potential for large-scale and low-cost production capability in existing CMOS foundries.

The European Commission launched the 15-member PLAT4M project in 2012 to build a Si photonics supply chain in Europe that would speed industrialization of the technology by enabling its seamless transition to commercial production.

The main objective of PLAT4M was to advance existing silicon photonics research foundries and seamlessly transition to pilot line operation and industrial manufacturing of products based on silicon photonics. The supply chain is based on three different but complementary technology platforms of Leti, STMicroelectronics and imec.

http://plat4m-fp7.eu/

www.leti-cea.com

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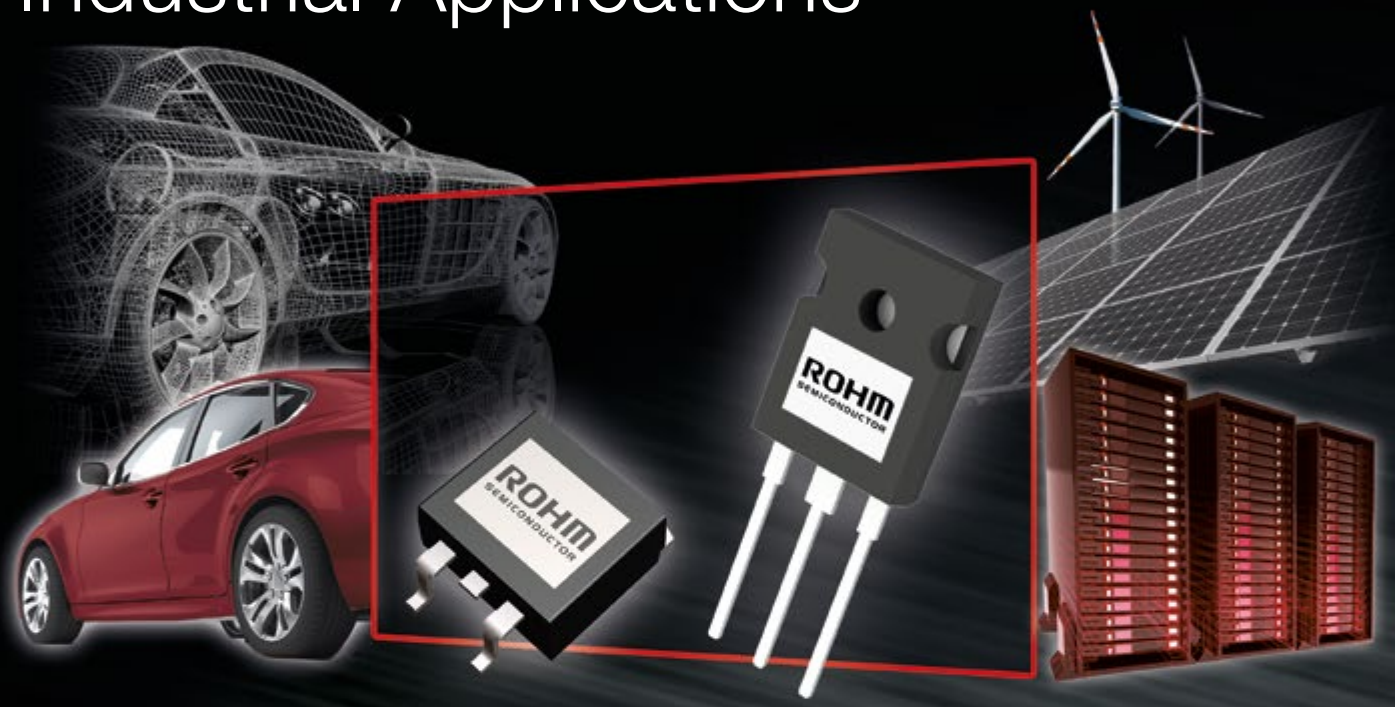

RGS Series (Automotive)

- Package: TO-247N
- 650V, 1200V
- Short circuit withstand time: 8-10 µs
- Low switching noise
- Built-in very fast & soft recovery FRD
- Based upon AEC-Q101

RGP Series (Ignition)

- Package: TO-252 (DPAK), TO-263S (D2PAK)
- BV_{CES} = 360V to 560V
- Low saturation voltage typ. 1.6V
- Avalanche energy 250 mJ to 500 mJ (Tj=25°C)
- Built-in ESD protection diode for gate
- Built-in resistor between gate and emitter (Opt.)
- Based upon AEC-Q101

RGTV / RGW Series (Industrial)

- ***High efficiency***
- ***Smooth and oscillation-free turn-off***
- ***Soft co-packaged diode***

- Light punch through & thin wafer technologies
- Package: TO-247N & isolated TO-3PFM
- 650V / 30, 50, 80A : RGTV @ Tc = 100°C
- 650V / 30, 40, 50A : RGW @ Tc = 100°C
- Low saturation voltage typ. 1,5V (Tj=25°C)
- Short circuit withstand time 2 µs (RGTV)

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Infineon receives Bosch Global Supplier Award

Recognized among thousands of suppliers: Robert Bosch GmbH honors Infineon with the 'Bosch Global Supplier Award'. This is the sixth time that Infineon Technologies AG has received the award from the world's largest automotive supplier. Bosch is already the third of global automotive market leaders this year, after Toyota and DENSO, to acknowledge the chip manufacturer for outstanding quality. With the award, the Bosch Group honors outstanding performance in the manufacture and supply of products or services – notably in the areas of quality, innovation, and logistics. Infineon supplies Bosch, for example, with radar chips for driver assistance systems, microcontrollers for the engine management, and chips for body and convenience applications. The theme of this year's award ceremony was 'Partners in Success' because to Bosch, its suppliers are much more than mere deliverers of parts and components. They are also partners in development and innovation who help Bosch stay competitive: "In the connected world, partnerships are becoming more and more important," said Dr. Volkmar Denner, Chairman of the Bosch Board of Management. "Hierarchical value chains are turning into value-added networks." The award was accepted by Dr. Reinhard Ploss, CEO of Infineon. "Infineon stands for quality, continuity, and innovation," said Dr. Ploss. "Our products help make the electric, autonomous, and data-secure vehicle a success. I am proud of the Infineon team's performance."

www.infineon.com/automotive

www.bosch-presse.de

BMW i Ventures Leads Strategic Investment in GaN Systems

GaN Systems, the world's leading provider of GaN power transistors, announced the closing of an investment round led by BMW's investment arm, BMW i Ventures. Consistent with its investment strategy, BMW i Ventures recognizes that GaN Systems' products maximize the efficiency of electronic systems while dramatically reducing size, weight and overall system cost. The investment will be used to expand global sales and accelerate new product development. BMW i Ventures joins the existing investors: BDC Capital, Chrysalix Venture Capital, Cycle Capital Management, RockPort Capital and Tsing Capital.

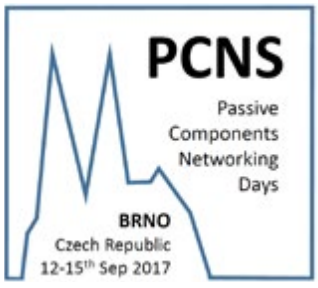
"GaN Systems' power transistors have created new possibilities for engineers to build the power electronics demanded by today's systems. Gallium Nitride-based transistors have become, in my opinion, the next big stepping stone in miniaturization. We have seen systems ¼ of the size while providing better efficiency than traditional silicon-based alternatives. With GaN, any system that needs power can become smaller, lighter and more efficient. These capabilities are particularly relevant in the automotive sector," stated Uwe Higgen, managing director, BMW i Ventures.

GaN Systems' CEO, Jim Witham, commented on the landmark investment, "From computer/phone chargers and data center servers to factory motors and electric cars, our customers have validated the GaN value proposition of small, efficient, low-cost power electronics. These benefits are widely recognized by the world's biggest companies across all industries."

www.gansystems.com

www.bmwiventures.com

First International Passive Components Networking Symposium



September 12-15th 2017 Brno University of Technology BUT will host the first international passive components networking symposium PCNS jointly organised by European Passive Components Institute EPCI and BUT. Capacitors, resistors, inductors together with other passive component news and latest development will be presented by industry leading manufactures and universities. The topics include introduction of new automotive components, high-rel applications, embroidered passives or on chip high energy capacitors.

The plenary speech will offer overview of passive components life and DPA failures by Serma Laboratories, followed by automotive sensors development trends by Valeo company. The hot topic panel discussion will follow the ESA SPCD conference topic in October 16: "use of commercial components for space applications". The keynote speech will be presented by ESA, ASRC (NASA) and Kemet Corporation. Capacitor, Resistor and Inductor half day seminars lectured by recognised industry experts are part of the PCNS pre-events. The courses are dedicated to HW engineers, application and component engineers, quality engineers, strategic buyer, distributor FAEs etc. PCNS, hosted by some European university, is intended to be organised as a bi-annual event complimentary to ESA SPCD symposiums the other year.

www.passive-components.eu/pcns

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Trolleybus image courtesy of
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Hitachi Europe Limited, Power Device Division email pdd@hitachi-eu.com

Celebrating 25 Years of Globally Leading Innovation

"Within 25 years, we have grown to be the global leader in precision cleaning due to our unwavering commitment to process improvement," says Dr. Harald Wack, President of ZESTRON worldwide. "ZESTRON prides itself on providing electronics manufacturers that have an ongoing need to eliminate long-term reliability concerns as electronics designs continue to increase in complexity, with the latest engineered cleaning agent technological developments for precision cleaning processes available."
In 1992, Dr. O.K. Wack, founder of ZESTRON, discovered the need for environmentally friendly cleaning agents for the electronics market. Within the next few years, ZESTRON began introducing several aqueous based VIGON® cleaning agents that quickly gained industry attention. With cleaning agent concentrations at 30% or greater at the time, ZESTRON cleaning agent technology performed at concentrations of 20%. In the ensuing years, continued R&D investment in product development reduced working concentrations further resulting in the launch of cleaning agents that performed at even lower concentrations. Additional product developments resulted in the launch of the first true pH neutral defluxing agent in 2009, and the first automatic concentration monitoring unit, the ZESTRON® EYE, in 2013. These industry leading advances enabled our customers to meet their cleaning challenges.

www.zestron.com

Upcoming ECPE Workshop's in September 2017

- **ECPE Workshop 'Power Supplies in Low Power Applications'**
  18 - 19 September 2017, Padova, Italy
  Chairmen: Prof. G. Spiazzi (University of Padova), Dr. M. Schlenk (Infineon Technologies), Dipl. Ing. (FH) J. Koszescha (ECPE)
- **ECPE Tutorial 'Thermal Engineering of Power Electronic Systems -** Part II (Thermal Management and Reliability)'
  10 - 11 October 2017, Nuremberg, Germany
  Chairmen: Prof. E. Wolfgang (ECPE), Prof. U. Scheuermann (Semikron)
- **ECPE Workshop 'Current Measurement for PE Applications in Lap Scale' -** 17 - 18 October 2017, Hamburg, Germany (programme will be published soon); Chairmen: Prof. N. Kaminski (University of Bremen), Prof. M. Bakran (University of Bayreuth)
- **ECPE Tutorial 'Power Circuits for Clean Switching and Low Losses'** 9 November 2017, Aalborg, Denmark
  Chairman: Dr. R. Bayerer (Infineon)
- **ECPE Workshop 'Reliability Engineering - 10 Years Robustness Validation'**
  January 2018 (calendar week 4), Stuttgart, Germany (programme will be published soon); Chairmen: Prof. E. Wolfgang (ECPE), Dr. J. Breibach (Robert Bosch)

http://www.ecpe.org/ecpe-events/ecpe-tutorials/

Carbon-Doping is not Needed to Achieve High Isolation in GaN-on-Si

At ICNS scientific conference Allos' co-founder and CTO Dr. Atsushi Nishikawa discussed common believes about GaN-on-Si: Firstly, that the usage of carbon would be inevitable, secondly that using interlayers in the buffer would be a source of leakage and thirdly that the choice of the right reactor hardware would be decisive to achieve good results. With the experimental evidence presented Dr. Nishikawa is challenging the validity of these three widespread believes. The common believe Dr. Nishikawa is questioning is that the usage of intentional carbon doping would be inevitable. Developers of GaN-on-Si epiwafers are suffering from the fact that crystal impurities from the growth process cause the isolation of GaN to be far below its theoretically possible values. To overcome these insufficiencies makers of GaN-on-Si epiwafers usually apply carbon doping to achieve the required isolation. Unfortunately, conventional methods of carbon and other doping have negative side-effects. In contrast Allos' results prove that by focusing on superior crystal quality and thick GaN layers the required low leakage currents can be accomplish without any intentional carbon or other doping. This not only avoids negative side-effects of doping but also widens the process window for further optimization of numerous manufacturing and electrical properties.

www.allos-semiconductors.com

Revenue Growth Driven by Industrial Applications and Power Supplies.

Growing Semiconductor Content per Vehicle Keeps Automotive Business Buoyant
Infineon Technologies AG reported results for the third quarter of its 2017 fiscal year (period ended 30 June 2017).
"Our forecast has been fully confirmed. The pace of growth in the third quarter was in line with expectations," said Dr. Reinhard Ploss, CEO of Infineon. "Demand is particularly strong for the power semiconductors we produce for various applications ranging from renewables to data centers. The market for electro-mobility also continues to accelerate. During the nine-month period ended June 2017 we acquired almost twice as much new business in this area for the coming five to ten years as in the entire previous fiscal year. Infineon is a leader in IGBTs for hybrid and electric cars, a technology which will prevail in this application for years to come. We are further expanding our strong position in this market. Overall, we confirm our outlook for the current fiscal year, despite strong headwinds caused by the weaker US dollar."

www.infineon.com

On-Board, Off-Board, and Every Kilometer Along the Way.

Wolfspeed's SiC MOSFETs and diodes are the only way to power best-in-class, future-ready EVs. And only we have been singularly focused on driving SiC device technology forward for nearly 30 years.

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Global Agreement to Address IoT

Bosch Sensortec's MEMS sensors portfolio added to Arrow's comprehensive IoT offering.

Arrow Electronics has signed a global distribution agreement with Bosch Sensortec to supply Bosch Sensortec products. Bosch is a leading supplier of MEMS (microelectromechanical systems) sensors worldwide. It has built on an initial base in automotive applications to expand its offering to consumer electronics markets and now provides a diverse portfolio of MEMS devices for the Internet of Things (IoT). Arrow offers an extensive range of IoT solutions, from component level through to complete secure, end-to-end deployable services. Since 1995, Bosch has designed and manufactured over 8 billion MEMS sensors and holds more than 1000 patents on MEMS technology. Its in-house expertise is fuelling a roadmap of products. Arrow's IoT portfolio includes a comprehensive range of hardware components, development platforms and software tools linked together by services to deliver the broadest available IoT offering.

www.arrow.com

www.bosch-sensortec.com

STMicroelectronics Reports 2017 Second Quarter and First Half Financial Results

"It was another solid quarter, with both net revenues and gross margin sequentially performing better than seasonality and above the mid-point of our guidance," commented Carlo Bozotti, STMicroelectronics President and CEO. "On a year-over-year basis, revenue growth came from all product groups and sales channels. In Internet of Things and smartphones, we continue to win with our complete portfolio of microcontrollers, sensors, analog and power management, connectivity and security solutions. In Smart Driving, we continue to capture opportunities both with products developed in our Automotive and Discrete Group, as well as from the rest of our organization which fit the needs of our automotive customers, such as sensors and general purpose analog.

"On top of our sales initiatives, during the quarter we improved our profitability thanks to our operating leverage, better product mix and manufacturing efficiencies driving our operating margin before impairment and restructuring to 9.6% in the second quarter.

www.st.com

Strengthening Presence in the AC Power Market

After steadily extending its AC/DC power supply portfolio in the last two years Recom wants to shift the focus further to this business segment. For that reason Recom reestablished the position of a Business Development Manager based in the company's headquarters in Gmunden, which will act as an interface between market-oriented distribution channels and globally acting development teams. Recom contracted power conversion specialist Michael Schrutka, who can look back at 15 years of experience in this segment – being active as a product manager for AC/DC modules in the last eight years. In his new position Michael Schrutka will actively support distribution teams in establishing innovative AC/DC products in the marketplace and focus on strengthening project support for key clients. The other way around his market knowledge can leave its mark on developing future products. In doing so Recom is confident to align its product development closer to the customers' expectations and to further extend its product portfolio ranging from 1W to 550W.

www.recom-power.com

Signing Worldwide Distribution Agreement

Power Integrations announced a worldwide distribution agreement with Future Electronics, a global leader in the distribution and marketing of electronics components. Commented Ben Sutherland, vice president of worldwide sales at Power Integrations: "Power supply, lighting and IGBT sub-system developers using PI products will have access to excellent technical help and pre- and post-sales support from Future's highly capable field applications engineering and support team. We look forward to leveraging the impressive reach and design capabilities of Future's experienced, highly technical sales force to identify new customers and drive increased design activity." Replied Matthew Rotholz, vice president of marketing for Future Electronics: "Power Integrations' energy-efficient, highly integrated ICs and gate drivers will benefit our customers by enhancing system reliability, reducing design cycle time and increasing competitiveness. We are delighted to add such an innovative and well-respected supplier to our linecard."

www.power.com

www.FutureElectronics.com

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Texas Instruments

HEVC 2018 – The 7th IET Hybrid and Electric Vehicle Conference

27-28 June 2018 | IET London: Savoy Place
Call for papers open now – deadline for abstract submission:
6 October 2017
As hybrid and electric passenger vehicles are becoming increasingly mainstream, such fast-paced consumer adoption brings about new operational challenges to meet the needs of a wide demographic of drivers. HEVC 2018 will highlight the current solutions being sought to support the design and development of electric vehicles, and the infrastructure needed to keep the momentum going.

Practical application and innovative trends in theoretical research will be shared at this popular knowledge exchange forum through technical presentations delivered by leading industry and academia.

This 2 day conference will show how the latest explorations and resolutions, in various stages of commercial use or phases of research, can:

- Give insights into how new technologies could provide practical applications for industry
- Discuss how using new innovative methods could solve business issue
- HEVC is one of the only UK-based technical conferences specialising in electric vehicles

www.theiet.org/hevc

Showcasing Color-Adjustable Smart Lighting Reference Design

Power Integrations and Casambi Technologies OY announced a new reference design, DER-612, describing a constant-voltage (CV), constant-current (CC) 12-watt isolated flyback power supply with power factor correction for smart lighting applications. The design includes a 3.3 V power supply to drive a Casambi CBM-001 Bluetooth® wireless module, which provides convenient dimming and color management control of the four-string LED load from 0 mA to 400 mA. The power supply operates over a universal input voltage range of 90 VAC to 265 VAC and achieves greater than 0.8 power factor across all line conditions.
Hubie Notohamiprodjo, director of product marketing for LED lighting at Power Integrations: “Smart lighting systems monitor and control sophisticated home and workplace lighting installations. The standby power needed for the control subsystem often negates any savings that high efficiency LEDs offer. Casambi’s low quiescent current draw combined with the very low standby consumption of InnoSwich-CH optimizes standby performance while maintaining instant light availability.” Adds Timo Pakkala, CEO and co-founder at Casambi: “The Power Integrations InnoSwitch-CH power supply controller has excellent efficiency, particularly at light load. This allows our module to operate continuously and effectively, resulting in a great user experience with high performance and scalability.”

www.casambi.com

http://www.power.com/der-612

Supplier of the Year 2016 Award

Continental´s Automotive Group gave this year´s “Supplier of the year 2016” award in the category discretes to Rohm Semiconductor. With about 100 production sites worldwide, Continental processed around 120 billion components which have been produced by more than 2,700 series suppliers in 2016. To determine the winners, the Continental Automotive Group performs a comprehensive, systematic review on strictly defined criteria. Only suppliers who deliver an outstanding performance in terms of quality, technology, logistics, costs and purchase conditions can excel and hope for the established award. Rohm received the award during the Supplier Day 2017 in Regensburg by Dr. Elmar Degenhart, Executive Chairman of the Board, Continental AG, and Günter Fella, Head of Purchasing at Continental Automotive. Dr. Degenhart emphasized during the ceremony, “Quality is now no longer a goal in the sense of an indicator of customer satisfaction but an absolute must. Adopting a systematic zero-defects strategy in all areas is a clear objective for our work. For this reason, all companies in the supply chain must make this standard of quality an integral part of their DNA so that all employees put it into practice every day and it characterizes every single process step.”

www.rohm.com/eu

KNOWLEDGE IS POWER

Massive power density in the smallest packages

Microchip Technology now offers an integrated switching power module designed specifically for height-constrained telecom, industrial and solid-state drive (SSD) applications. These products come in an impressive thermally-enhanced package that incorporates inductors and passive components into a single, molded power converter. The slim packages simplifies board design, saves space and eliminates concern over passive components that may introduce unexpected electromagnetic interference (EMI).

Highlights

- Variety of module package offerings (small to large, fit to application)
- High power density with integrated magnetic and passive components
- Performance (efficiency, thermal, transient response)
- Reliable (power and thermal stress tested)
- Low EMI (CISPR 22 Class B ratings on modules)

microchip DIRECT
www.microchipdirect.com

MICROCHIP

www.microchip.com/powerpromo

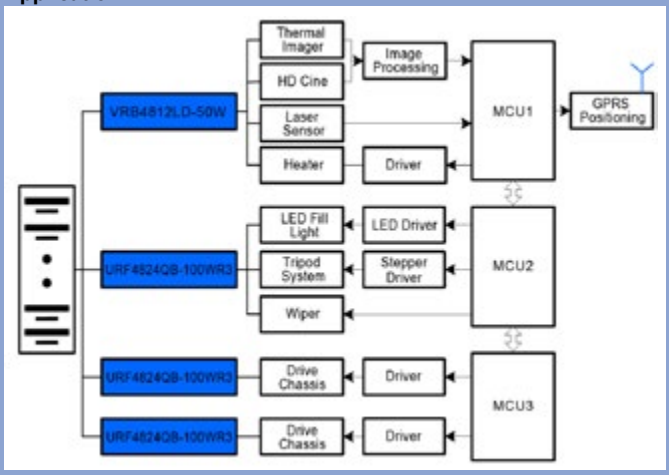
18-75V Ultra-wide Input Voltage DC/DC Converter URF48xxQB-100WR3 Series

Along with the upgrading of traditional manufacturing and increasing input in industrial automation, traditional industries such as industrial control and communication industries increase their demand for medium-power DC/DC power supply. Following the trend, MORNSUN introduces a new 100W DC/DC converter—URF48xxQB-100WR3 series which are of 18-75V ultra-wide input voltage and can be widely used in industrial control, communication, electricity and railway; such as intermediate bus of Industrial control system, distributed power system, wireless network equipment system, medium and high power control system, and long-distance DC power supply system.

With efficiency up to 94%, URF48xxQB-100WR3 series seek for further "cost reduction and efficiency improvement". In addition to quality guarantee, service assurance and technical support, this series also provide customers with better choice with its high reliability and excellent performance.

With continuation advantages of R3 DC/DC converters, the converters of wide input voltage keep extending profiles. URF-QB-75W/150W/200WR3 series in same package will come soon and so do 24V (9-36V) input voltage URF-QB-100WR3 series.

Application:

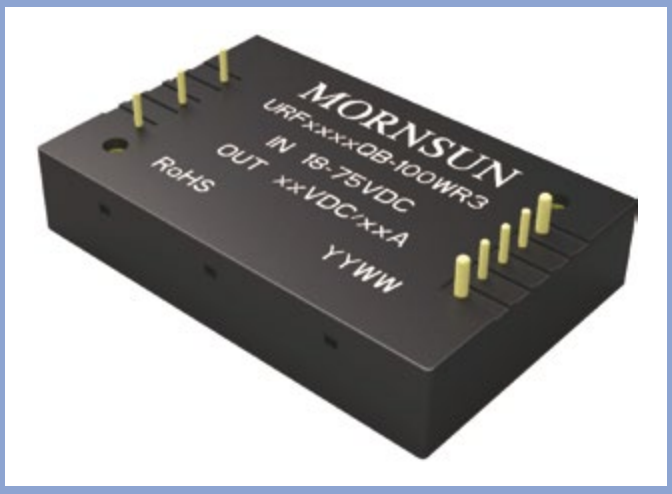


- Intelligent Inspection Robot for Power Substation
- Intelligent substation inspection robots all day and night inspect the power transmission equipment to monitor and ensure the safety of equipment, including data collection, video surveillance, temperature and humidity, pressure measurement. When accidents occur, the robot can even identify equipment failure replacing staff and protect the staff from safety risk.

The robot requires strong endurance and has a higher requirement for power module. The two 100W DC/DC converters offering 4:1 input voltage(18-75V) and high efficiency in the application form a dual drive, simplifying circuit design and reducing power consumption.

Features:

- Ultra-wide input voltage range: 18-75VDC
- Isolation: 2250VDC
- Operating temperature: -40 to +85°C
- Input under-voltage protection, output short circuit, *over-current, over–voltage and over-temperature protections
- 1/4 Brick international standard pin-out, connecting piece and heat sink package available
- Meet EN60950



Picture: URFxxxxQB-100WR3

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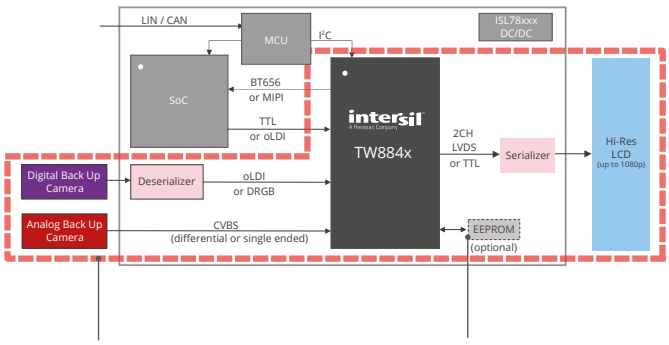
- **Frozen Detection**—Monitors the SoC and camera output to determine if they are in a frozen or corrupted state. If the TW884x detects any issue, it bypasses the SoC and instantly displays the rearview camera video.
- **Bypass Capability**—The TW884x's rearview camera bypass architecture decouples the camera-to-display signal path from the rest of the infotainment system, which simplifies the functional safety architecture of the system.

Rear Camera Reliability System Architecture



Decouple the camera-to-display path
The TW884x provides a hardware based path that can directly drive rear camera video to the LCD.

EEPROM fast boot function enables fast boot with no external MCU needed.

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COLD SPLIT Provides Significant Cost Advantages for SiC Substrates and Devices

SILTECTRA has developed a kerf-free wafering technique based on a spalling process that uses externally applied stresses to separate crystalline materials along crystal planes with well-defined thickness1. We use a laser-conditioning process to spall the material along a pre-defined layer with high precision. Our process leads to material losses far below 100µm per SiC-Wafer which is significantly lower than alternatives like wire sawing. Geometrical parameters like bow, warp and TTV are superior due to the micrometer precision of the laser process. This allows further reduction of wafer thickness and utilizing the SiC-material more than two times.

Furthermore, COLD SPLIT can also be applied as an alternative to back-side grinding of the final device wafer, which has the potential to reclaim most of the SiC-Wafer for a second processing run providing significant cost advantages for SiC-devices.

By Jan Richter (CTO), Johannes Froehling (Advisory Board Member), SILTECTRA GmbH

Wafering of SiC is generally done using diamond- or slurry-based wire sawing processes. These sawing processes lead to substantial kerf-loss of precious material, which increases cost per wafer.

COLD SPLIT is now available for SiC and provides a kerf-free technology that promise to reduce – if not eliminate – kerf-loss, subsurface damage and lapping steps1. The process consists of four sequential processes (see Figure 1):

- a proprietary laser procedure to condition a defined layer within the material
- coating the material with a custom designed polymer foil
- cooling the system to induce enough stress to precisely split the material along the laser-conditioned layer
- preparation of residual boule for the next wafer by grinding and standard wet-chemical cleaning to remove the polymer film from the substrate

Figure 1: COLD SPLIT approach

The sequentially approach is significantly faster than current technologies. Process time for one SiC wafer is only several minutes compared to more than one hour with the current wire saw process.

Figure 2 gives examples of wafers right after the cold split processes, with surface and bulk properties that allow immediate grinding and polishing steps by short-cutting lapping completely.

Figure 2: SiC Wafer with different diameters (2,4 & 6 inch) after splitting using identical process parameters for COLD SPLIT.

The system equipment includes a laser tool as its core component. The laser tool allows working on a wide variety of materials just by using different types of laser sources and optical path modifications.

SILTECTRA's CTO Dr. Jan Richter says, "On substrate level, COLD SPLIT is the fast and cost-efficient solution for the demand and cost challenges as above mentioned - since it allows the SiC providers to increase their SiC wafer production immediately by 90%, without a need to increase crystal growth capacities. COLD SPLIT avoids the typical kerf-loss of wire saws in the process of slicing ingots or boules to wafers. Instead of transforming a lot of wafer material into sawdust, COLD SPLIT is able to increase the amount of wafers that can be cut from an ingot or boule."

However, the cost advantages do not stop at the substrate level. The same, or potentially, even higher utilization improvements of a factor of two can be made in the back-end by replacing back-side thinning of final devices.

Dr. Jan Richter says, “COLD SPLIT TECHNOLOGY will have an impact on device manufacturing technology, by replacing capital and cost intensive back-side grinding processes.
It has significant yield improvements and enables sub-100 µm thin SiC Devices. In addition to these improvements the remaining wafer can be reclaimed for a second device manufacturing run”

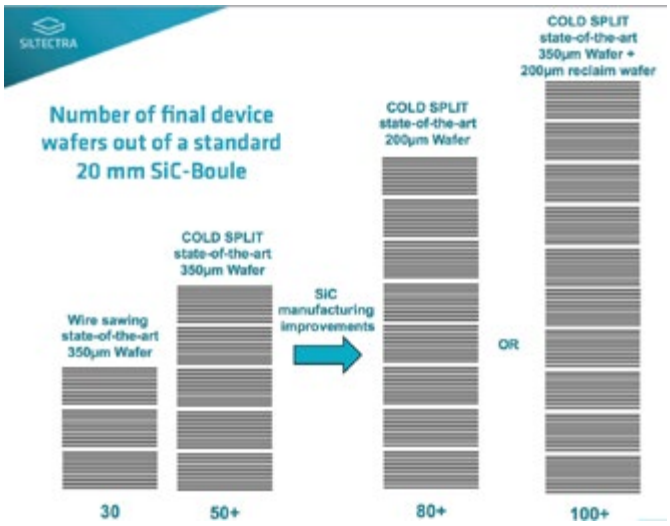

Figure 3: Number of final device wafers out of a standard 20 mm SiC-Boule

Figure 3 depicts the number of final device wafers possible out of one single 20mm SiC-boule. For this boule wire sawing yields 30 wafers, whereas replacing wire sawing with COLD SPLIT would yield 50+ wafers. The better geometrical properties of the COLD SPLIT wafers enable the reduction of wafer thicknesses and provides a positive impact to the following process steps. This would boost device wafer numbers even further to 80+ wafers out of the boule for 200µm thick wafers. Combined with COLD SPLIT backside-thinning and reclaiming residual wafers this number can be as high as 100+ device wafers per boule. In total, the same SiC-Boule would give enough material for three times more final devices.

Essentially this figure shows, that final SiC-device costs can be reduced by 20-30% with the better utilization of the required SiC-material. This is without further improvements in quality and yield that stem from the better geometrical properties of the wafers.

“The continuing interest of high-profile industry partners paved the way for Siltectra to set up a new facility in Dresden. There we can offer pilot line capabilities to i) qualify our process on customer SiC material, ii) offer wafering and thinning services and, iii) adapt COLD SPLIT into other materials”, Johannes Fröhling (Advisory Board member) comments.

For advanced discussion, we are inviting members of the eco-system to discuss our technology and challenge the market demands especially for power electronic and RF.

REFERENCES

[1] M Swoboda, Christian Beyer, Ralf Rieske, Wolfram Drescher, Jan Richter, Laser Assisted SiC Wafering Using COLD SPLIT Material Science Forum (2017) Volume 897

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jan.richter@siltectra.com

SiC Power Modules for a Wide Application Range

Innovative Power Devices for a Sustainable Future

By J. Yamada Mitsubishi Electric, Power Device Works, Fukuoka, Japan and
E. Thal Mitsubishi Electric Europe, Ratingen, Germany

Development Milestones of Mitsubishi SiC Power Modules
Today's SiC power modules from Mitsubishi Electric (see Figure1) are belonging to the first phase of SiC-commercialization that had started around 2010.

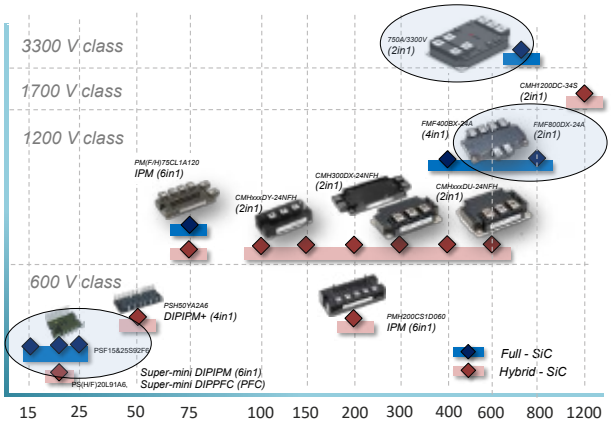

Figure 1: Today's SiC-module range (X-axis: module rated current in A; Y-axis: voltage class)

However, the SiC technology development started in Mitsubishi Electric much earlier, more than 20 years ago, see [1]. In the first decade 1994…2004, the R&D efforts were mainly oriented on the SiC chip technology itself, both for SiC MOSFETs and SiC Schottky diodes. After this, in the years 2005…2009, the focus was on the achievable system benefits by using SiC-modules in inverters. For this purpose, several SiC-inverter demonstrators were designed and evaluated under different applications. The commercialization phase of SiC-modules started in the years 2010…2014. Several types of full- and hybrid SiC-modules were launched in this period and the first industrially manufactured inverters with Mitsubishi SiC-Modules appeared, mainly in Japan. In parallel, the SiC-MOSFET chip technology was continuously undergoing further improvement steps; see the 1200V development roadmap in Figure 2 for example.

Particularly since 2015, SiC-modules started to enter many new application areas. This expansion process is still ongoing and even gaining speed. The today available SiC–power modules from Mitsubishi Electric are covering a wide current and voltage range, see Figure 1.

This article is explaining the innovation potential of SiC-technology in power electronic systems by referring mainly to three examples of SiC power modules selected out of the product range given in Figure 1:

- 15A/600V Full SiC DIPIPM, type name PSF15S92F6
- 800A/1200V Full SiC Dual Module, type name FMF800DX2-24A
- 750A/3,3kV Full SiC Dual Module, type name FMF750DC-66A

15A/600V Full SiC Super mini DIPIPM (PSF15S92F6)
This full SiC Super mini DIPIPM was introduced in October 2016 into the new Mitsubishi room air conditioner "Kirigamine" FZ and Z-Series

High energy efficiency is a key requirement for inverterized air conditioning systems. The PSF15S92F6 was developed for home appliances, such as air conditioners, washing machines, refrigerators

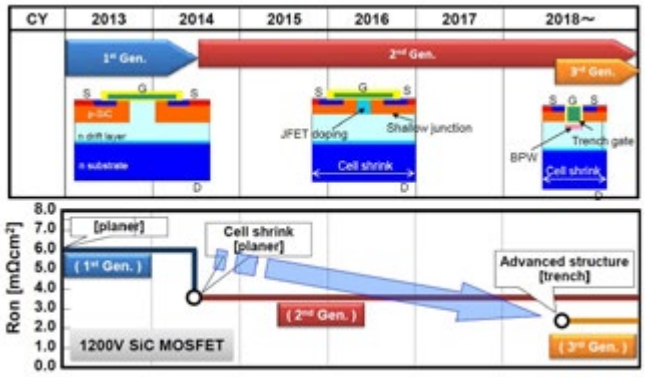

Figure 2: 1200V SiC MOSFET chip development roadmap

Figure 3: Room air conditioner "Kirigamine" series

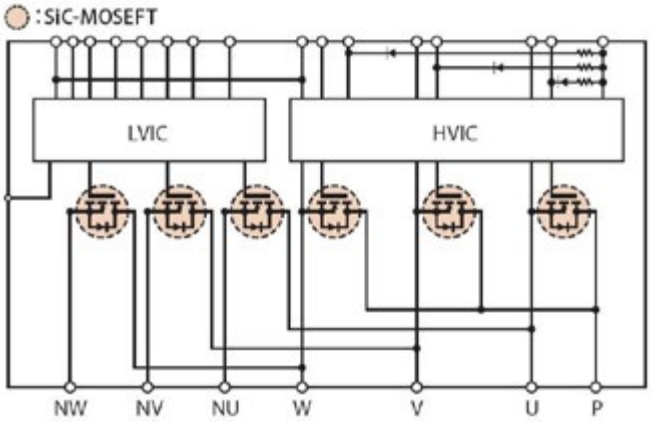

Figure 4: PSF15S92F6 circuit diagram

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[2]. The circuit diagram is shown in Figure 4. It contains a 3-phase inverter with SiC-MOSFETs and their driving ICs. The package outline is shown in Figure 5. Compared with a conventional 15A Si-IGBT-DIPIPM manufactured in the same module package the new full SiC DIPIPM is offering 70% lower power loss under same application conditions (see Fig.6). By using the PSF15S92F6 an outstanding energy efficiency of the new “Kirigamine” room air conditioners was reached.

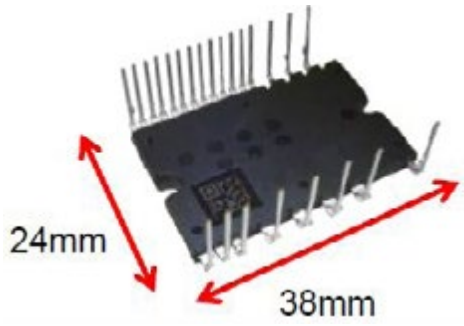

Figure 5: Package outline PSF15S92F6

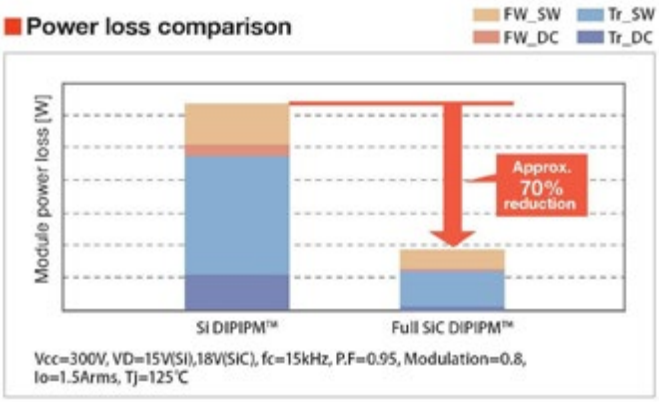

Figure 6: Power loss comparison Si- versus Full SiC-DIPIPM

Another application benefit of the Full SiC-DIPIPM is shown in Figure 7: The smooth diode recovery at MOSFET turn-on is remarkably reducing the radiated noise, thus relaxing the requirements towards the EMI-filters.

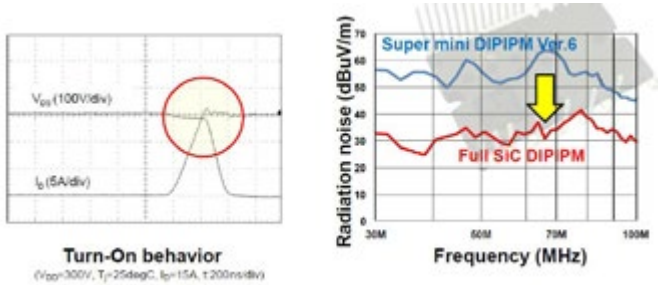

Figure 7: Improved EMI by smooth FWDi recovery

Advanced 800A/1200V full SiC Dual Module (FMF800DX2-24A)
In April 2015 we reported in Bodo’s Power [3] about a new 800A/1200V Full SiC Dual module (type name FMF800DX-24A). For efficient driving and protecting this device a dedicated gate driver was developed by Power Integrations GmbH [4]. Recently Mitsubishi has launched an advanced version of this 800A/1200V full SiC Module having the new type name FMF800DX2-24A. The low loss SiC-chip set is the same, but the package is modified compared to the previous version, see Figure 8. The internal package inductance is less than 10nH; the isolation voltage is Viso=4kV AC. Real Time Control

Figure 8: Advanced 800A/1200V full SiC Dual module FMF800DX2-24A

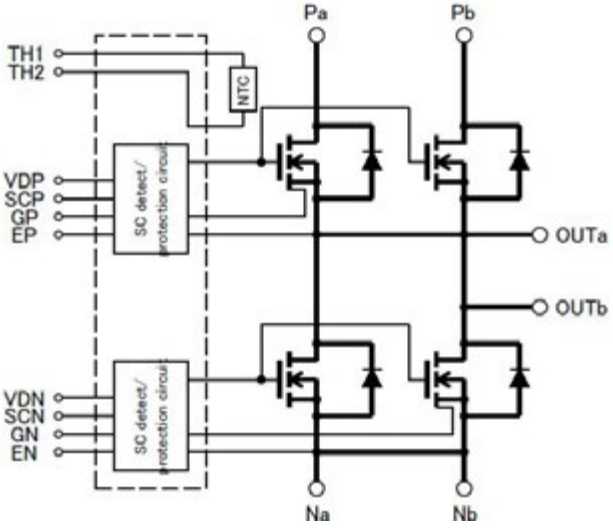

Figure 9: FMF800DX2-24A internal circuit diagram

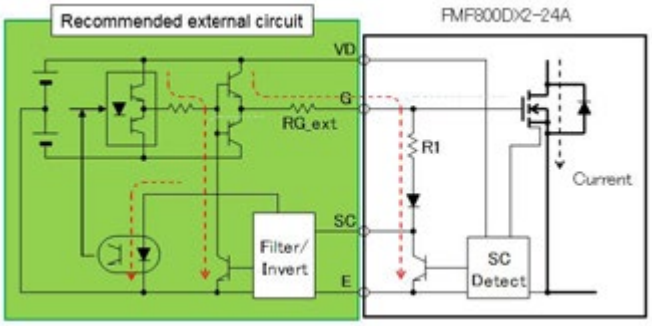

Figure 10: Recommended gate drive circuit for SC-protection

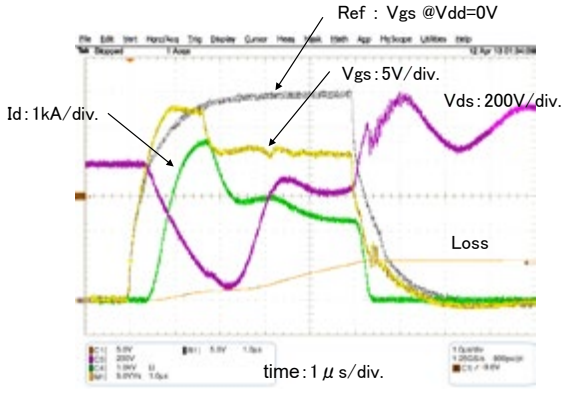

Figure 11: SC-waveforms during RTC-operation

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(RTC) circuits are incorporated into the module both for P- and N-side SiC-MOSFETs, see Figure 9. This RTC is using the MOSFET-chip-integrated current sensors for SC-detection and efficient SC-current limitation by fast gate-voltage shutdown; see Figures 10 and 11.

When comparing the power loss of the 800A/1200V full SiC-module FMF800DX(2)-24A to its Si-counterpart under same application conditions, the advantage of SiC becomes evident [1], see the 110KW-inverter example given in Figure 12.

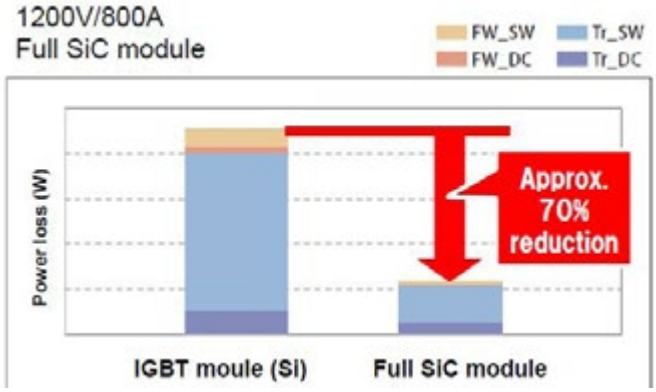

Figure 12: Power loss comparison Si-IGBT vs. Full SiC-module (both 800A/1200V)

There are two possible ways for utilizing this advantage:

a) If keeping the switching frequency the same, as with conventional IGBT-modules, the inverter power loss will be drastically reduced. This is improving the inverter efficiency and is offering a new grade of freedom for shrinking the inverter size by reducing the heatsink dimensions. This is interesting for applications where high inverter power densities are required, specifically if the space for installing the inverter is limited.

b) If keeping the inverter power loss at the same level as with IGBT-modules (means the inverter efficiency and heatsink size are kept the same) the switching frequency can be increased by a factor of 3…5. In applications having large inductive storage components this will offer a new grade of freedom for reducing the size (and cost) of those inductors.

Of course, any superposition of both aspects a) and b) is possible for obtaining the best advantage in a given application from using the full SiC-module FMF800DX(2)-24A.

750A/3300V Full SiC Dual Module (FMF750DC-66A)

In June 2015 Mitsubishi Electric announced the installation of first Railcar propulsion system using 1500A/3300V All-SiC Power Modules into a Shinkan-sen Bullet Train [5] (Fig.13). The system benefits were described as 55% inverter size reduction and 33% inverter weight reduction.

In [6] the newly developed 750A/3300V full SiC Dual module FMF750DC-66A was introduced. It contains SiC-MOSFETs with

Figure 13: First All-SiC propulsion inverter in Shinkansen Bullet Train

antiparallel SiC-Schottky-Barrier-Diodes. In order to get a low internal package inductance (<10nH) and a good current sharing between the paralleled chips a new dual package has been adopted, called LV100-package (see Figure 14).

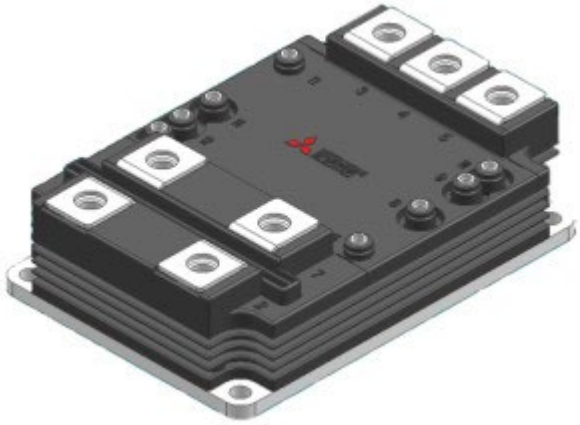

Figure 14: 750A/3300V full SiC Dual module in LV100-package

The switching waveforms of 750A/3300 Si-IGBT and FMF750DC-66A are compared in Figure 15 (turn-on) and Figure 16 (turn-off).

The FMF750DC-66A switching energy is much lower compared with its Si-counterpart: Eon is reduced by 61%; Eoff is reduced by 95%.

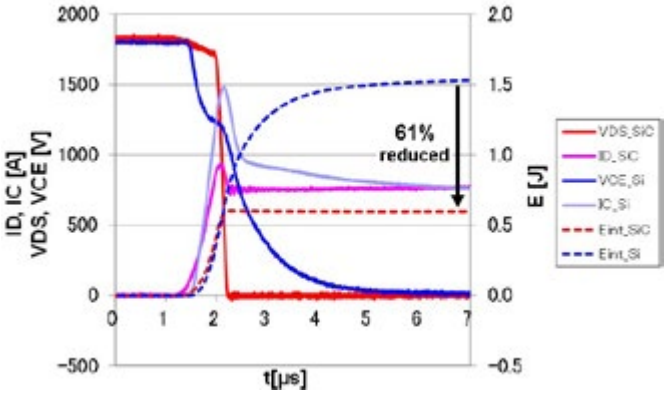

Figure 15: Turn-on waveforms

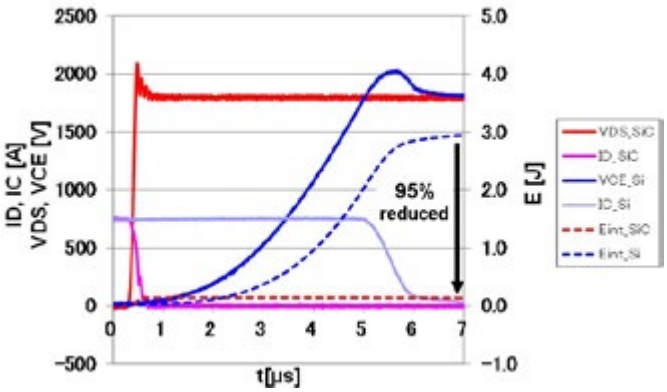

Figure 16: Turn-off waveforms

This dramatic switching loss reduction by SiC can be utilized in several directions, as described earlier in chapter 3: a) for reducing the inverter system size or b) for increasing the switching frequency or, as a combination of a) and b), depending on the priorities in the given application.

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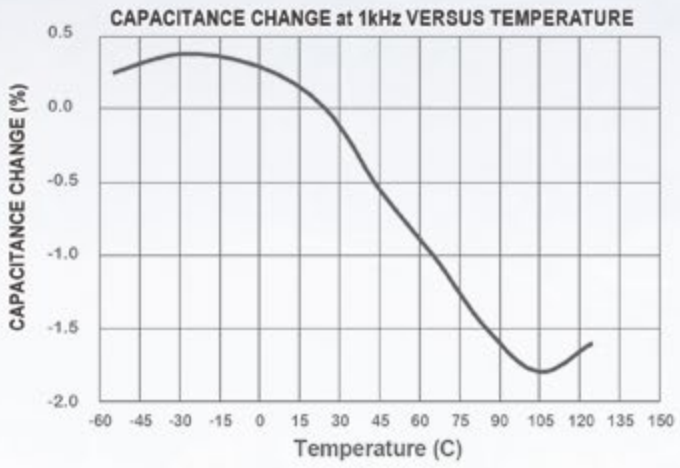

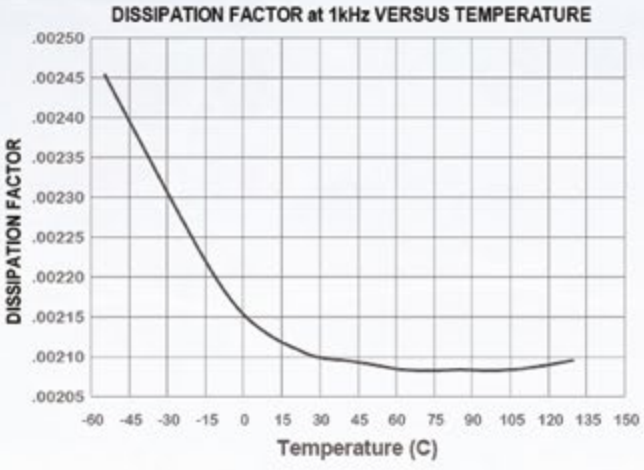

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In order to meet the specific environmental and reliability requirements in traction applications the new FMF750DC-66A has passed several confirmation tests [6]:

- 1000h HTRB at Vds=2810V; Vgs=-10V; Tj=175°C
- Cosmic radiation stability test
- 1000h HTGB at Vgs=+/-20V; Vds=0V; Tj=175°C
- Power cycling test at Tj(max)=175°C
- 1000h H3TRB test at Ta=85°C; RH=85%; Vds=2100V; Vgs=-10V
- 1500h switching test at Vds=1650V; Id=354A; fo=20Hz; fc=1kHz

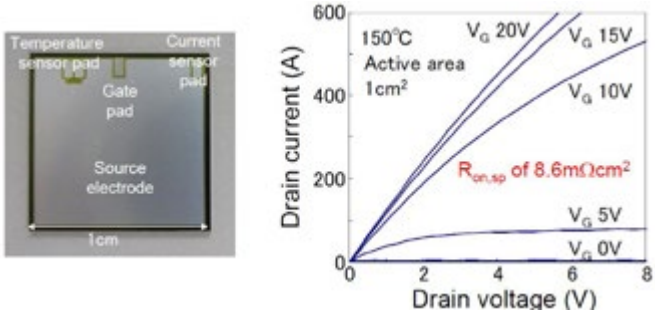

Figure 17: 300A/1200V SiC-MOSFET chip

As result, it was confirmed that the performance of FMF750DC-66A is suitable for traction system use. This new all-SiC power module has about 80% lower switching loss than a conventional Si power module. By applying the FMF750DC-66A to the propulsion inverter in a railcar it was possible to reduce the total power loss by 30% compared with the existing system.

Figure 18: Ultra-compact inverter with 86kVA/dm³ for HEV

R&D efforts for expanding the SiC technology

In parallel to the design-in-activities of already existing SiC power modules (see Figure 1) there are multiple R&D activities ongoing for adopting the SiC-technology to new applications.

One very promising direction is the use of SiC in automotive power train applications. In [7] the test production of 300A/1200V SiC-MOSFET chips was reported, having the size of 10x10mm² and a specific Ron=5,9mΩcm² @ Vg=15V; Ids=300A, see Figure 17. Even though this is a 2 years old result, it is still (as of Sept.2017) the world's largest size 1200V SiC-MOSFET chip.

Another example for Mitsubishi's pioneering efforts to introduce SiC-technology into automotive applications is shown in Fig.18. This ultra-compact 430kVA-inverterized power control unit for HEV-application is incorporated into a housing of 275x151x121mm³. It represents the world's highest inverter power density of 86kVA/dm³ [8].

Another important R&D activity is focusing on the expansion of SiC-technology towards higher blocking voltages. In [9] the successful fabrication of 8,1x8,1mm² 6500V SiC-MOSFET chips with embedded Schottky-barrier-diode (SBD) was reported, see Figure 19 & Figure 20.

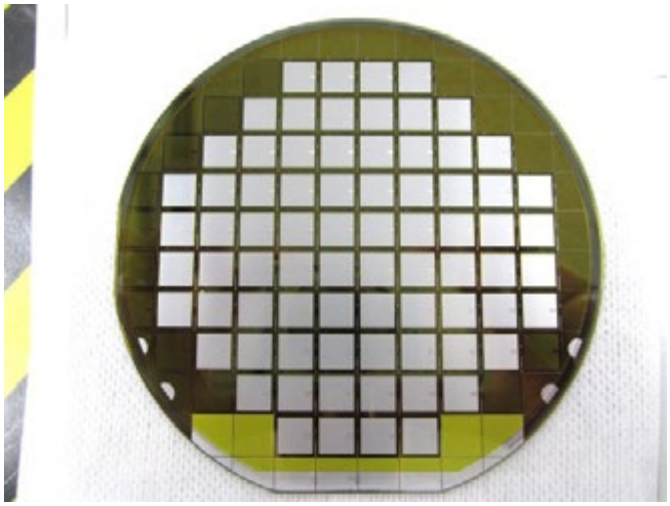

Figure 19: Wafer of 6500V SiC-MOSFET with embedded SBD

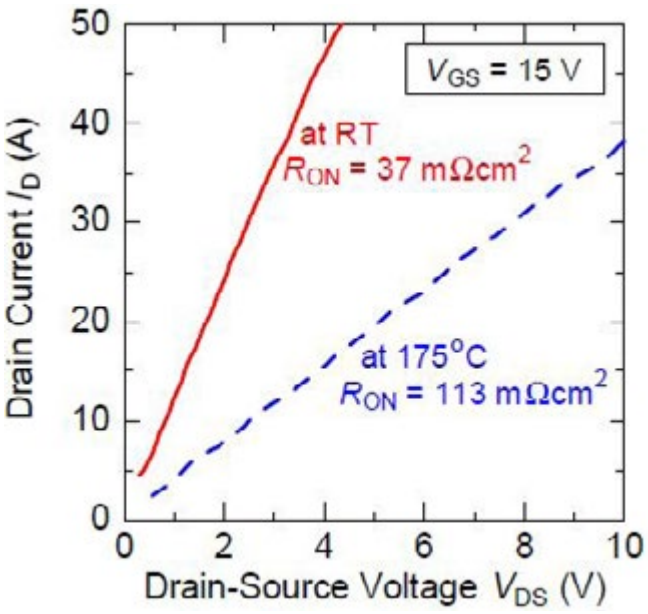

Figure 20: Drain characteristics of SBD-embedded 6,5kV SiC-MOSFET

This new approach is offering two advantages:

a) The integration of an antiparallel SBD into the SiC-MOSFET-chip allows reducing drastically the needed active chip area in a power module. The example in [9] is indicating a reduction factor of 3 to 4 compared to modules with separate SBD-chips, thus allowing module designs with very high current densities.

b) The chip-embedded SBD is enabling a full unipolar operation of the MOSFET in both directions without degradation. No parasitic increase of on-resistance of the diode operation will happen for such chip design, because the bipolar body diode of the SiC-MOSFET is always safely by-passed by the embedded SBD. The long-term reliability test results reported in [9] show that such SiC-MOSFET-structure is completely free from the well-known bipolar degradation effect caused by the expansion of stacking faults.

Summary and outlook

Mitsubishi Electric is a pioneer in exploring the SiC-technology for power modules. A wide range of SiC-power modules with currents between 15A and 1200A and voltage ratings between 600V and 3300V is already available. The main advantage of today's SiC power modules vs. conventional Si-IGBT-modules are the drastically reduced switching losses. Depending on the specific requirements in a given inverter application this advantage can be used either for reducing the inverter size/improving the inverter efficiency or for increasing the switching frequency. The application area of SiC-based inverter systems is continuously expanding. By its wide R&D activities on SiC Mitsubishi Electric is continuously enlarging the fundaments for the coming SiC-power semiconductor age.

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Efficient MCU-Controlled High Power PFC with Two-Phase Current Modulation Compared with SiC MOSFET Switching Performance

The efficiency of High Power (3 kW and above) AC-DC converters featuring Power Factor Correction (PFC) is an important factor affecting many aspects of design, including heat dissipation, overall physical dimensions, and type of cooling. Economic considerations impacting customers also play a role in design development. Technological solutions based on Digital Control architecture, along with high power discrete components from IXYS, compared with SiC MOSFET´s, help increase the efficiency of high power AC-DC converters with PFC.

By Anatoliy Tsyrganovich, Leonid Neyman, and Abdus Sattar, IXYS Corporation

Overview

IXYS Digital Power Control technology expands the development of efficient AC-DC converters with Power Factor Correction by completely utilizing the fast switching capabilities of new semiconductor components at increased load current and voltage. This design also incorporates Digital Inrush Current Control technology, and High Power Two-Phase Digital Power Factor Correction. Functional control is based on Zilog's 8-bit Z8F6481 MCU.

This design, incorporating an AC-DC converter with more than 3 kW output power, active PFC, and two-phase interleaved conversion, was developed to confirm the possibility of achieving a high efficiency of conversion at high power by utilizing the following improvements:

- Quasi-resonant mode at high power
- Peak current modulation concept
- MOSFET based current switch with short reverse recovery time
- Fast boost rectifier with fast forward recovery capabilities
- New low loss high frequency 30A inductor to store and efficiently pump energy into output bulk capacitor and load

Utilizing the quasi-resonant mode minimizes power loss from recharging the MOSFET's output capacitance along with any stray capacitance in high power mode. The two-phase interleaving architecture with current modulation and 12-bit resolution multiplying DAC with fast comparator that acts as a high-resolution amplitude discriminator generates a current waveform that accurately mimics the reference waveform. Therefore, power factor is high and distortions are low, thereby contributing to the converter's efficiency.

The current switch TURN OFF time is reduced by shifting the gate voltage into negative area using a fast IXYS high current gate driver with negative supply voltage.

The body diode of IXYS X-class MOSFET, a Si-based Super-Junction (SJ) device, is used as a boost diode. Body diodes of X- or X2- class SJ MOSFETs provide extremely good forward recovery performance, which reduces forward recovery voltage substantially (up to three times) and adds to converter efficiency. The inductor is designed and built by MPS Industries for high efficiency at high current and high switching frequency.

The MCU-based digital control also optimizes the converter's overall performance, including limiting inrush current, programmable fault protection schemes, and optimizing the converter's performance within a range of loads and input voltages.

Features

The Efficient MCU-Controlled High Power PFC with Two-Phase Current Modulation design offers the following features:

- Conversion power, maximum 3 kW @ 240V power line
- Input Voltage 240V ± 10% AC 50/60 Hz
- Output Voltage 450V – 650V, programmable
- Output Current 6.7A @ 450V
- Output Voltage Ripples <5% at full load
- Input Current Ripples <8%
- Load Variation Range >8x
- Device Conversion Frequency 80 – 100 kHz at high power
- Programmable Overload, Overvoltage, and Brownout Protection
- Digital Inrush Current Control
- Soft Start
- Power Good Status
- Switching Performance with SiC MOSFET´s

Potential Applications

This design provides a basis for developing a variety of AC-DC Converter power management applications with IXYS power devices and an MCU, including the following:

- Air conditioning systems
- EV charging
- Battery charging
- High power LED lighting
- Principles of Operation

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The design approach and schematic for the Efficient MCU-Controlled High Power PFC with Two-Phase Current Modulation is described in the References section [1].

The quasi-resonant mode is adaptive to varying peak current value and is controlled by the MCU. The SJ MOSFET switch is turned OFF at each instance of peak current. The inductor's (and MOSFET's drain) voltage begins to fall in a resonant manner. When the inductor voltage becomes equal to the input sine wave voltage, the comparator generates a pulse to the MCU. Because the resonant parameters tend not to change substantially in a particular design, the required delay time needed to turn the switch ON at zero inductor current is predictable. These values are stored in the MCU's Flash memory and loaded in the timer to generate the next ON pulse upon arrival of the aforestated comparator pulse. This turns the MOSFET switch ON every time at zero or near-zero inductor current.

The converter operates in quasi-resonant mode at high power unless the load power drops below 50% of peak power. If output power drops below 50% of peak power, the converter deactivates the slave converting phase and operates in discontinuous conduction mode with an active snubber to dump the resonant oscillations (See References [2]). The output voltage is controlled primarily by pulse density modulation via delay time. Fine tuning of the output voltage is still accomplished by modulation of peak current reference amplitude.

Figure 1: Boost Switching of SJ IXFH50N85X in a Typical Application
Legend: Yellow – Inductor/Drain Voltage; Green –inductor current; Red – gate voltage;
Note: The bottom of the scope snapshot is a zoom of the top portion of the area between two white lines.

Turn OFF time of current switch is a substantial component in power loss and should be as short as possible. To reduce turn OFF time, a gate driver with current capabilities equal to limits of the IXFH50N85X SJ MOSFET gate bonding was utilized. Additionally, the gate voltage in the off-state was shifted into negative area by powering the gate driver with negative supply voltage. This approach is very effective in shortening Turn OFF time as shown on Figures 1 and 2. Figure 1 depicts the conventional gate driving approach with gate resistor equal to 5 Ohms and lower voltage at ground level. Figure 2 depicts waveforms of the boost stage with the gate driver rated at 30 A and common node sifted to minus 15 V, which results in almost two times reduction in the overall switching time.

For comparison, silicon carbide device IXFN50N120SK was used in the same application. The gate driver common node was shifted to –5 V due to gate specification. The gate charge time for SJ IXFH50N85X is 25 ns, i.e. shorter than one of Si MOSFET that is 31 ns, but overall turn OFF time is in the same range (see Figure 3). Therefore, X-class MOSFETs can be used to design circuits that provide switching characteristics similar to one that utilizes SiC MOSFETs.

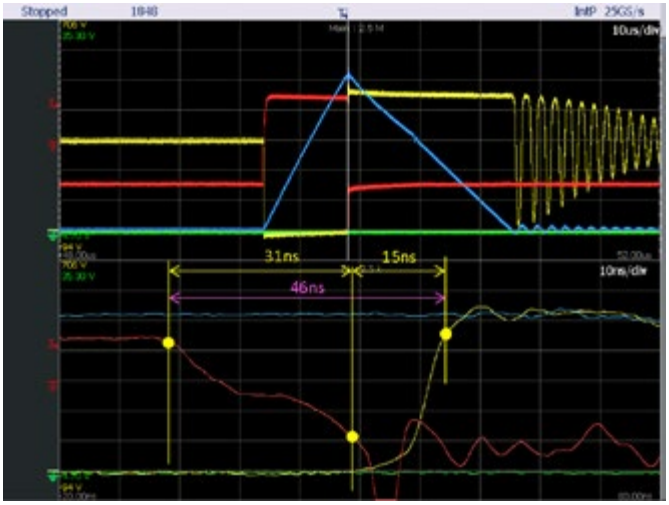

Figure 2: Boost Switching of SJ IXFH50N85X in an Enhanced Driving Application
Legend: Yellow – Inductor/Drain Voltage; Blue – inductor current; Red – gate voltage; Note: The bottom of the scope snapshot is a zoom of the top portion of the area between two white lines.

Fast turning switch OFF creates an overshoot on the MOSFET drain that depends on forward recovery time of the boost rectifier diode. Application with diode DHG40C1200HB creates an overshoot of 200 V over output PFC voltage as seen in Figure 1. The diode is fast and is ideal for reverse recovery in hard switching at continuous conduction mode. For critical conduction mode, hard switching is single-sided and requires fast forward recovery to reduce overshoot. The body diode of Si MOSFET was determined to be the best for use where fast forward recovery time is required. Using SJ IXFH50N85X (the same device as in switch) as a diode resulted in reduction of overshoot to 100 V (see Figure 2). At 30 A peak current at the moment of switching, using the body diode of MOSFET decreases power loss at boost

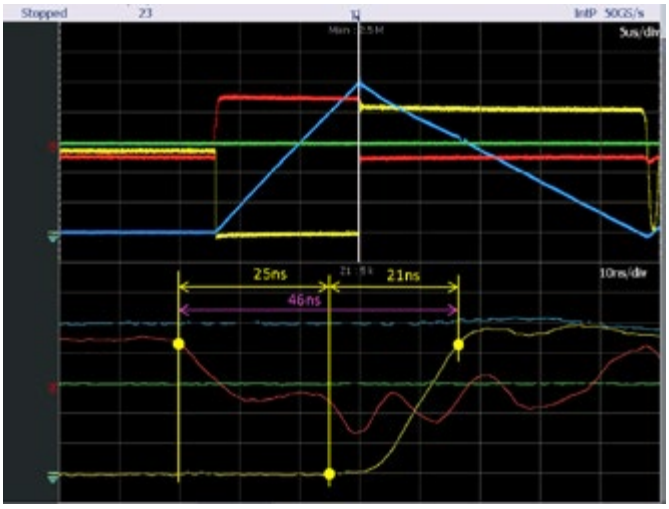

Figure 3: Boost Switching of IXFN50N120SiC in an Enhanced Driving Application
Legend: Yellow – Inductor/Drain Voltage; Blue – inductor current; Red – gate voltage; Note: The bottom of the scope snapshot is a zoom of the top portion of the area between two white lines.

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diode by two times compared with DHG40C1200HB, thus substantially contributing to increase in efficiency of the PFC converter.

At high switching currents and frequencies, inductor is as important as other components. Saturation of the inductor at peak current causes loss of the device's efficiency, because reducing inductance increases the inductor's current, but does not result in increasing stored energy.

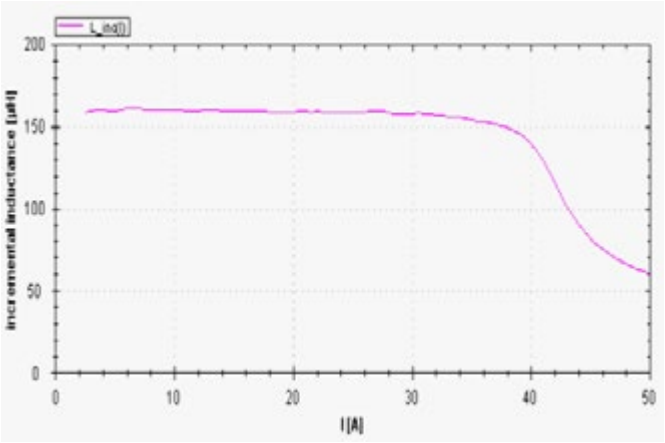

Figure 4: Inductance as a Function of Current for PFC Applications by MPS Industries

MPS Industries had developed a high-frequency inductor for high power with excellent magnetic characteristics for PFC applications (see Figure 4). Use of this inductor provides steady efficiency within a wide load range, up to peak load power.

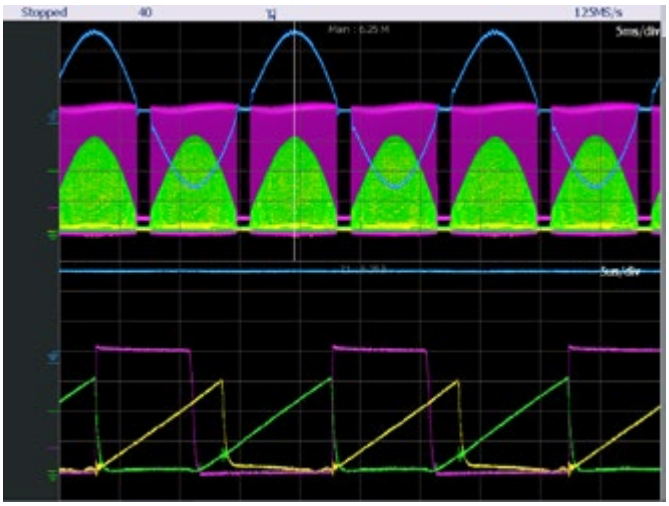

Figure 5: Power Line Current Waveform
Legend: Yellow and Green – first and second inductor charging currents; Blue – power line current; Magenta – second inductor voltage
Note: The peak inductor current amplitude is 30 A at AC input of 240 V. The Voltage on the inductor is 400V. The bottom of the scope snapshot is a zoom of the top portion of the area between two white lines.

Peak current modulation allows power line current to copy a form of the AC line input voltage, which is used as a reference. In this design, DAC is used to provide reference voltage for peak current modulation. Rectified and scaled input sine wave is applied to analog DAC input, while digital DAC input is used to control the amplitude of DAC output in accordance with prediction and feedback control. Figure 5 shows an illustration of current modulation.

Hardware Implementation

IXYS' MCU-controlled PFC, which consists of an MCU Module, a Main Power Board, and Auxiliary Board, is shown in Figure 6. The MCU and Auxiliary Modules are implemented as add-on devices powered by an auxiliary power supply. The MCU Module contains a connector for MCU programming. The MCU should be programmed before powering the entire system.

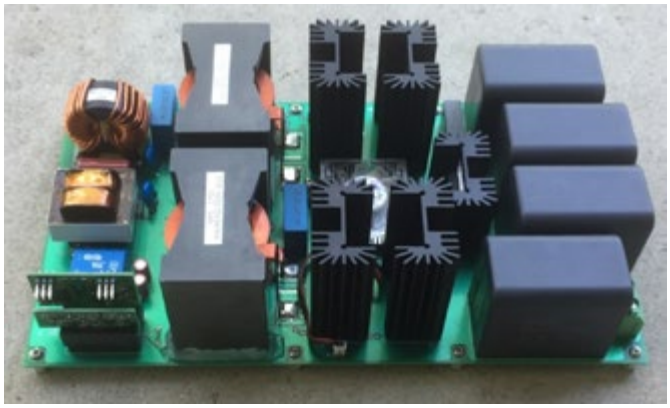

Figure 6: Main Power Board with MCU and Auxiliary Modules

The Main Power Board is a four-layer surface-mount board that provides easy access to test points. Power dissipated on MOSFETs is less than 54 W at 3000 W output power. This board may be powered from a 50 Hz or 60 Hz 220/240V AC source. Auxiliary power supply provides ±3.3 V for the MCU and ±12 V for the gate drivers on the Main Power Board.

Efficiency of MCU Controlled PFC

The efficiency of the reference design schematic is determined for the conversion circuitry by excluding the diode rectifier and AC filter. At a load power of 3000 W, the power loss is 54 W, which corresponds to an efficiency rate of 98.2%. Additional power loss is attributed to the Diode Bridge and AC line filter inductors.

Summary

This MCU-controlled PFC is a continuation of digital power control designs based on Zilog's F6481 series of MCUs, which offers ample flexibility in implementing a unique control algorithm that aids in creating efficient power systems. The primary focus of the 3 kW PFC converter is on increased efficiency through design approaches and new power MOSFET devices from IXYS. The fast switching capabilities of X-class SJ MOSFET and fast forward recovery time of the SJ MOSFET's body diode are key components that help achieve the goal of increasing the efficiency of PFC and other power converters designed with digital power control.

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Thyristors for Current Impulses Commutation in Amplitude Range of Hundreds kA and Duration Range of Hundreds µs

There was developed a new generation of silicon pulse thyristors adapted for commutation of current impulses with amplitude 100-300 kA, 100 – 1000 µs width. A variety of improvements was done in the layers of silicon structure, topology, and technology of anode and cathode contact generation. It is experimentally proved that commutation of current impulse with amplitude up to 250 kA and 500 µs width by thyristor with 100 mm silicon element is possible.

By Anatoly Chernikov, Dmitry Titushkin and Alexey Surma, Proton-Electrotex, Orel, Russia
Vladimir Goncharenko and Alexandr Mizintsev NIIEFA-ENERGO, S.-Peterburg, Russia

INTRODUCTION

Development of semiconductor switches able to commute short current impulses with amplitude of tens to hundreds kA is significant for progress in design of pulse power supplies of high power electrophysical equipment [1].

High-spec pulse semiconductor devices used in such switches must meet a number of unique technical requirements, in particular:

- Commutation of currents with rate of growth exceeding 1000 A/µs. Typical requirements are 2000-10000 A/µs.
- Commutation of short pulses of high amplitude currents. Ratio of current amplitude in the commutated pulse to average thyristor current may reach 100 or more.
- Simultaneous engaging of separate devices in a series assembly for commutation of current pulses with high rate of growth.

Pulse thyristors are widely used as such pulse semiconductor devices. However, when commuting impulses with rate of rise of on-state current (di/dt) over 1000 A/µs, significant difficulties occur related to nonsimultaneous switching-on of thyristor element over the whole surface [2-5].

A comprehensive solution for this issue will be using of thyristors with celled «multiemitter» topology used for Gate Turn-Off thyristors (GTO) and Integrated Gate Commutated Thyristors (IGCT) [6], because such thyristor switches almost simultaneously over the whole surface due to small crosswise size of each emitter cell. However, for such kind of devices the bigger part of the surface (50% and more) is used to place gate, what significantly decreases the allowed amplitude of current impulse.

Another solution to this issue will be using a special pulse device – Reverse Switching Dynistor (RSD) [7]. Switching-on of such device goes over the whole surface as well, what allows reaching the highest amplitudes of pulse current for the semiconductor switches up-to-date [8]. Nevertheless, there is a disadvantage of this solution, which is necessity to use very complicated equipment needed to launch RSD. Moreover, it costs approximately same price with device.

Thus, it is very important to develop a new engineering solution, which will let increasing allowed pulse current of «conventional» pulse thyristor. Following this introduction there is a set of technological solutions, which allowed developing pulse thyristor able to commute current impulses with extremely high amplitude in important for practical application range of 100-1000 µs.

DESIGN FEATURES AND PRODUCTION PROCESS

Semiconductor layers

In semiconductor element, there is a relatively low-doped p-base (layer resistance under n-emitter 500-1000 Ohm/square). And its dopant profile ensures maximum built-in electric field within this layer. This allows reaching high on-state rate of spread, minimal value of switching delay and drastic decrease in switching delay variations of thyristors in series assembly.

There as well was applied a p-emitter with controlled effectiveness.

In semiconductor element of «conventional» power thyristor there is usually a dependency of n-base thickness (Wn) and values of ambipolar diffusion length of electron-hole pairs in this layer (L) not less than 3 (Wn/L>3). This is determined by necessity to provide the required values of the blocking voltages and dv/dt – sustainability. In on-state, however, distribution of excessive electron-hole pairs over the surface of the semiconductor element is strongly inhomogenous and, as a result, distribution of electric field strength is inhomogenous too.

The p-emitter layer, which is used in the new pulse thyristors, has a limited maximum concentration of dopant impurity. The applied diffusion technologies of its formation together with low temperature technology used to form the anode ohmic contact (sintering) allow regulating its injection rate with very high level of repeatability and

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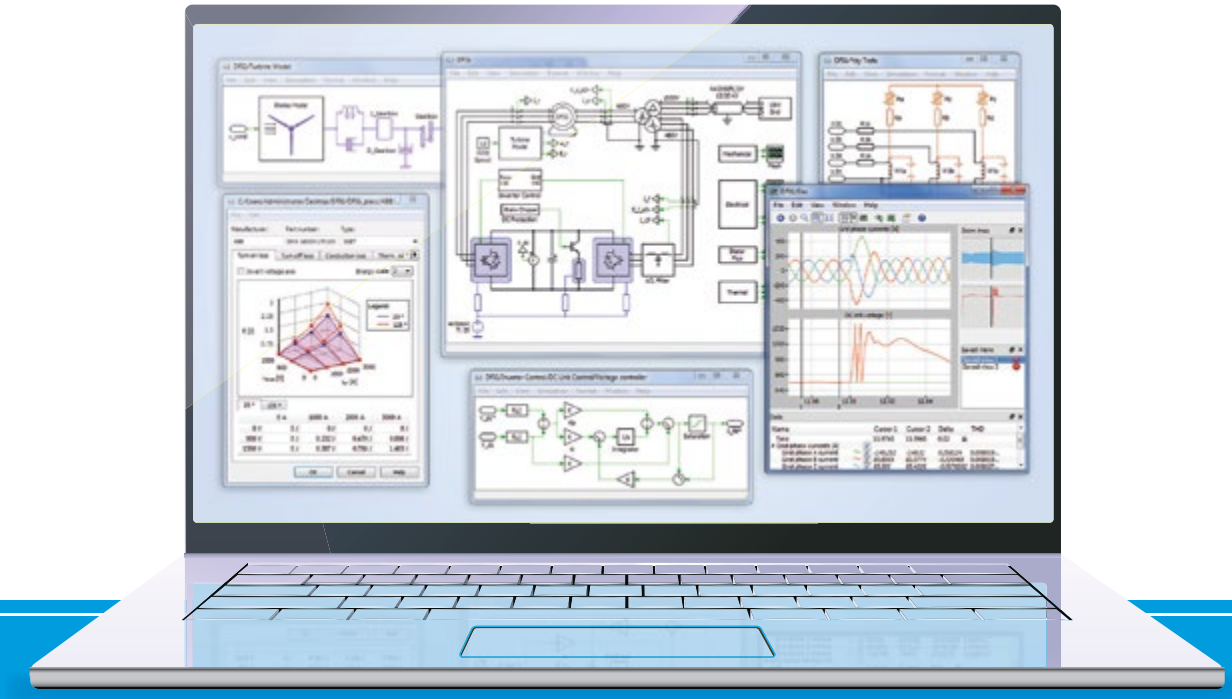

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getting very homogenous distribution over the surface of the semiconductor structure.

Usage of p-emitter with controlled effectiveness allows lowering Wn/L dependency down to 1 and less. As a result, there is a more even distribution of electric field strength over the structure thickness.

In Figure 1, as an example, there are results of calculation of distribution of excessive electron-hole pairs concentration and electric field strength with anode current flow of 2000 A/cm2 density for typical thyristors with conventional p-emitter and p-emitter with limited effectiveness. It is clear that electric field strength peak in n-base of the thyristor with limited effectiveness p-emitter is remarkably lower.

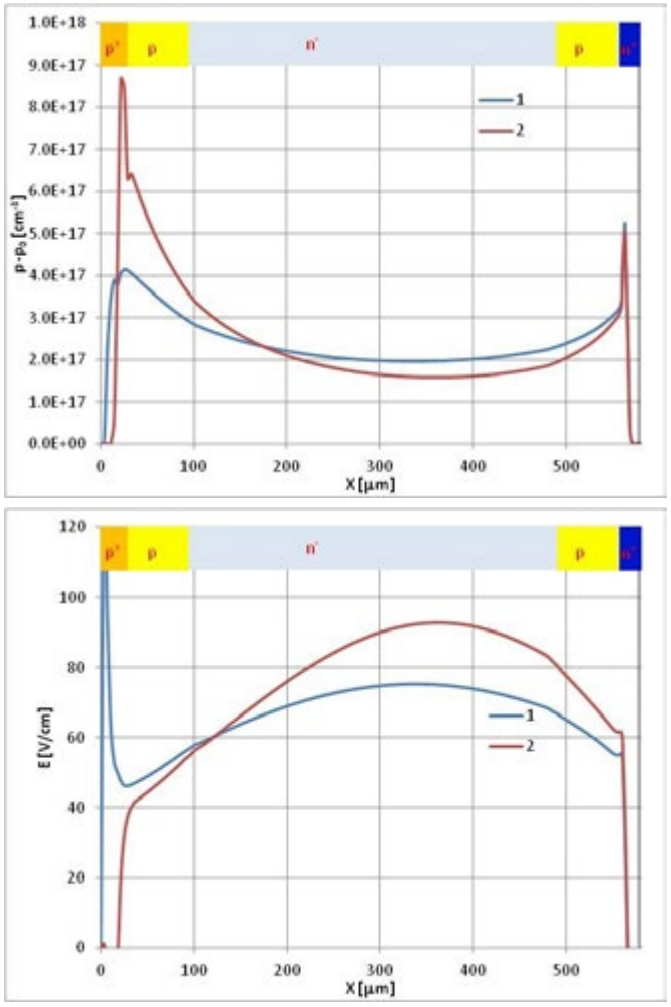

Figure 1: Typical axial distributions of the electron-hole pairs concentration p-p0 (a) and electric field strength E (b) for thyristor with "conventional" p-emitter (1) and for thyristor with limited effectiveness p-emitter.

Consequently, the thyristor with limited effectiveness p-emitter has a lower corrected local loss power compared to the conventional thyristor with the same voltage drop. When the heat release processes are considered as adiabatic, it allows lowering the local overheat of the semiconductor element for short current impulses down to 20%.

In such a way, energy required for the identical overheat compared to the conventional thyristor for the structure with controlled effectiveness p-emitter is gonna be about 20% higher.

Auxilary thyristor

Pulse power thyristor with big surface of the silicon element and distributed gate (DG) has an auxilary thyristor (AT), the cathode of which is connected with DG and anode is common with the thyristor structure. AT purpose is to form amplified gate current pulse applied to DG, which has a considerable length of perimeter. Usually AT structure is formed in a shape of a rather narrow ring, about 1 mm width, which rounds the main gate electrode of thyristor. However, during the commutation of current impulses with rate of rise over 1000 A/µs, density decrease of current flowing through the AT can go on rather slow. To decrease the density of current flowing through the AT, a so-called distributed AT is applied, which happens to be a «complete» thyristor structure (Figure 2).

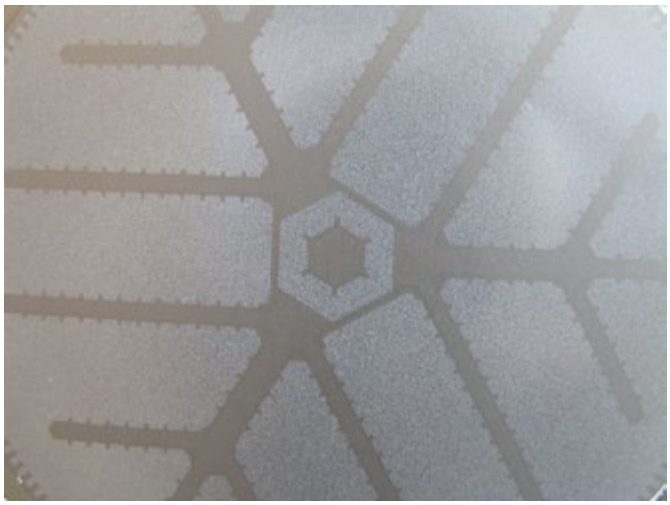

Figure 2: Distributed auxiliary thyristor (in the center)

Another factor, which allows decreasing the power loss and overheat of the auxiliary thyristor is a fast drop of current in the AT after switching of the main thyristor. Switch-on delay time of the main thyristor should accordingly be minimized. Usage of the low-doped p-base, described in part A, allows reaching this result. In Figure 3 there are shown the typical dependency of current and voltage on time during switch-on of the thyristor. It is shown that the dependency of voltage on time has two intervals of rapid drop: the first corresponds to the AT switching-on, and the second corresponds to the main thyristor switching-on. Switch-on delay time of the main thyristor in terms of the AT, which can be evaluated with this curve, equals about 0.7 µs.

Topology of distributed gate

When designing topology of distributed gate, one of the most important issues can be defining the optimal turn-on time of thyristor over the whole surface (during commutation of current impulses with specified form and width). Computer modelling of electrical and thermal processes during thyristor commutation of current impulse with high amplitude and high rate of rise shows:

The highest absolute difference of temperature between the hottest spots on the surface of thyristor element (adjacent to gate area) and the coldest spots (most distant from gate area and with the highest switching delay) is reached at the moment of full switching of thyristor over the whole surface. Further occurs a significant (but not complete) flattening of temperature distribution over the semiconductor element surface. The reason for such an effect is positive temperature dependency of peak on-state voltage (VTM): early switched and initially more heated areas, during parallel operation with cooler ones (later switched), conduct current with relatively lower density.

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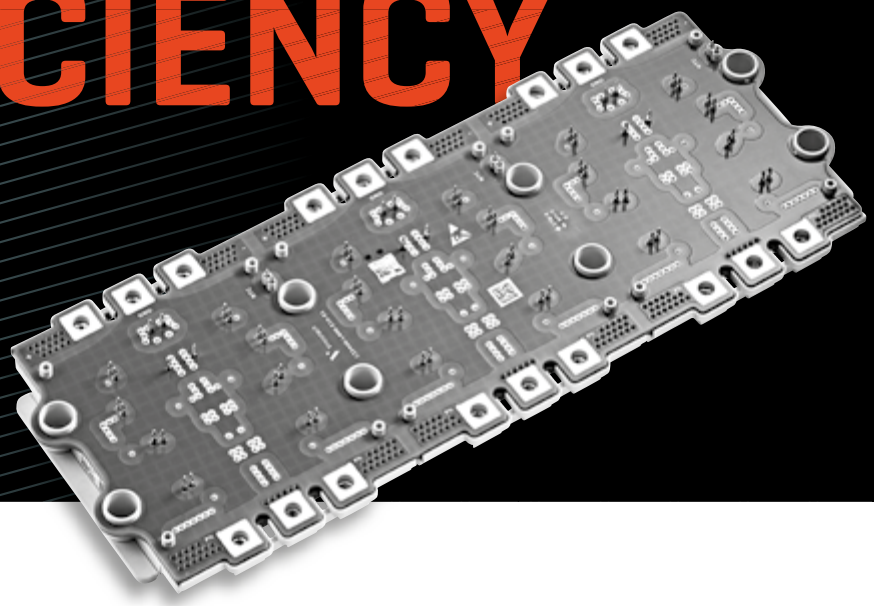

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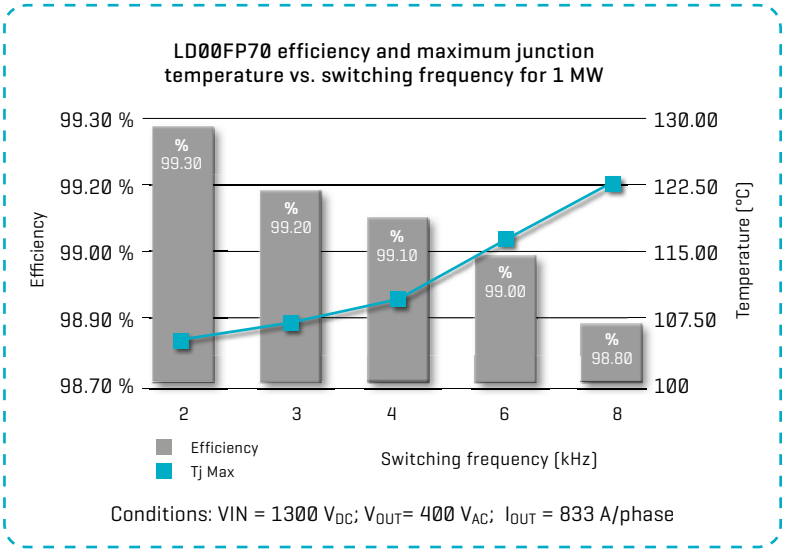

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To reach acceptable low temperature difference over the surface of thyristor element during commutation of current impulses with form close to half sine wave it is enough to ensure full switching of all the surface of thyristor not later the moment, when current of impulse reaches 0.8 of peak value. As an example, in Figure 4 there are the calculated dependencies of current density on time for the spots of the thyristor structure, which are located at the various distance from the border of the amplified gate electrode during commutation of current impulse with 250 kA amplitude and 4000 A/µs rate of rise in initial section. Thyristor element has the following characteristics: 580 µm silicon wafer thickness, 55 cm2 of active surface, 50 µs complete turn-on time. It is clear that current density during the on-state distribution process doesn't exceed the maximum, which corresponds to the maximum valued of the anode current. In Fig. 5 there are calculated values of temperature of the hottest and coldest spots on the surface of thyristor It is clear that maximum absolute temperature difference on the element surface is about 18°C, and by the moment of maximum overheating of the thyristor element this difference decreases approximately to 11°C, which is just about 6% of the absolute value of maximum overheating of thyristor element.

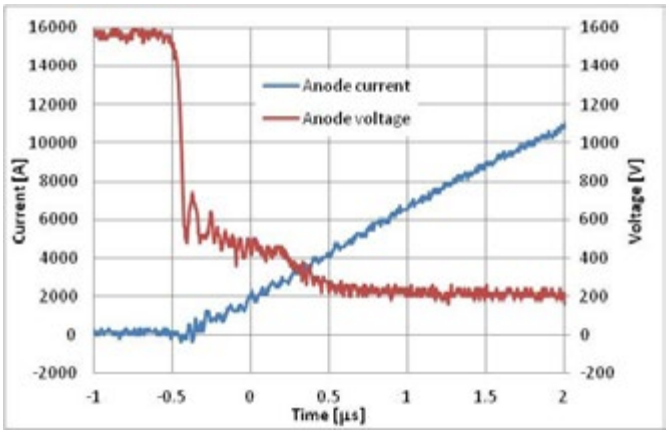

Figure 3: Typical dependencies of current and voltage on time during switch-on.

Contacts

Anode contact of semiconductor structure with molybdenum disc of thermal compensator made with help of low-temperature sintering by finely divided silver paste [9]. Using it for pulse thyristors can give the following advantages.

- Increase in load-cycling capability. In conditions of short current impulses commutation with extremely high amplitude conduction, each current impulse is followed by very severe thermal cycle for connection of silicon with molybdenum, because silicon is heated up to 200°C temperature, and molybdenum disc, except a fleet layer adjacent to silicon, remains cold. Interlocking joints, result of sintering technology, have very high load-cycling capability [10, 11].
- Increase in load-cycling capability. In conditions of short current impulses commutation with extremely high amplitude conduction, each current impulse is followed by very severe thermal cycle for connection of silicon with molybdenum, because silicon is heated up to 200°C temperature, and molybdenum disc, except a fleet layer adjacent to silicon, remains cold. Interlocking joints, result of sintering technology, have very high load-cycling capability [10, 11].
- During traditional connection process of silicon with molybdenum disc (silumin alloying) the surface layers of silicon structure are being dissolved with silumin. And after that it is impossible to ensure characteristics identity of anode emitter on the surface of structure. And as a result, it is typical for traditional technology to show increased density variance of current over the structure surface. Sintering technology excludes such a disadvantage [12].

To guarantee reliable cathode pressure contact cathode gasket made of molybdenum with special coating is used. The choice was made after long lasting significant investigation and testing of various materials and coatings. The selected gasket ensures high load-cycling capability of the contact, low electrical and thermal resistance, no decalage after continuous operation, including commutation of big volume (over 100000) current impulses with high amplitude.

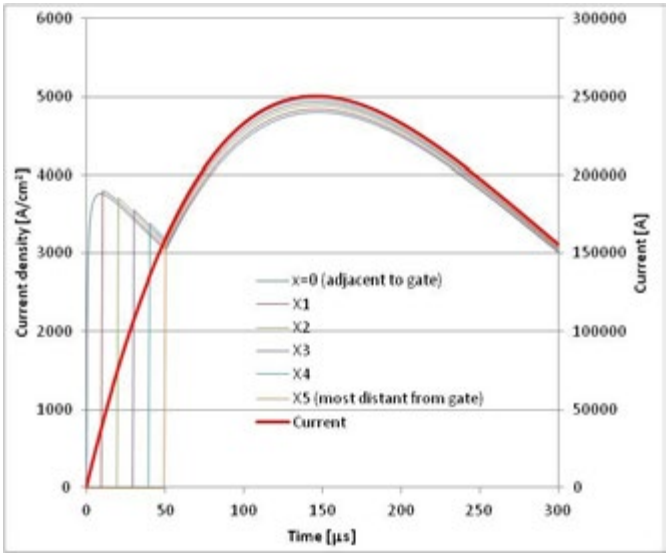

Figure 4: Calculated dependencies of current density on time for the spots of the thyristor structure, which are located at the various distance from the border of the distributed gate electrode.

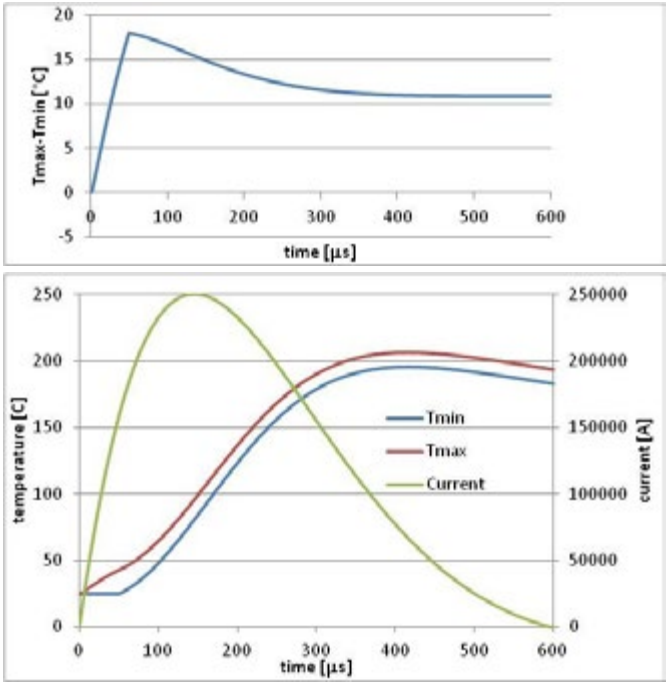

Figure 5: Calculated dependencies of thyristor element temperature during commutation of current impulses with extremely high amplitude.

Table 1. Maximum allowable ratings

** With a saturated reactor 3 µs, di/dt during saturation no more than 8 kA/ µs*

Symbols and parameters		Units	Values	Conditions	
On-state					
I_{TAV}	Mean on-state current	A	3200	Tc= 90 °C, Double side cooled 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	5024	Tc= 90 °C, Double side cooled 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA 79.0 91.0	75.0 86.0	$T_j=T_{j\,max}$ T_j=25°C	180° half-sine wave; 50 Hz (tp=10 ms); single pulse; $V_D=V_R$=0 V; Gate pulse: I_G=2 A; diG/dt>1 A/ms
			$T_j=T_{j\,max}$ T_j=25°C	180° half-sine wave; 60 Hz (tp=8.3 ms); single pulse; $V_D=V_R$=0 V; Gate pulse: I_G=2 A; diG/dt>1 A/ms	
I^2t	Safety factor	A^2s*10^3 25900 34365	28125 36980	$T_j=T_{j\,max}$ T_j=25°C	180° half-sine wave; 50 Hz (tp=10 ms); single pulse; $V_D=V_R$=0 V; Gate pulse: I_G=2 A; diG/dt>1 A/ms
			$T_j=T_{j\,max}$ T_j=25°C	180° half-sine wave; 60 Hz (tp=8.3 ms); single pulse; $V_D=V_R$=0 V; Gate pulse: I_G=2 A; diG/dt>1 A/ms	
Blocking					
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	2800	$T_{j\,min}< T_j <T_{j\,max}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	2900	$T_{j\,min}< T_j <T_{j\,max}$; 180° half-sine wave; 50 Hz;single pulse; Gate open	
V_D, V_R	Direct off-state and Direct reverse voltages	V $0.85*V_{DRM}$ $0.85*V_{RRM}$	$0.75*V_{DRM}$ $0.75*V_{RRM}$	$T_j=T_{j\,max}$; Gate open	
			T_j—25 - 50 °C; Gate open		
Triggering					
I_{FGM}	Peak forward gate current	A	50	$T_j=T_{j\,max}$	
V_{RGM}	Peak reverse gate voltage	V	7		
Switching					
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive (f=1 Hz)	kA/ms	8 30*	$T_j=T_{j\,max}$; V_D—0.67-V_{DRM}; I_{TM}—2 I_{TAV}; Gate pulse: I_G—20 A; di_G/dt—10 A/ms	
Thermal					
T_{stg}	Storage temperature	°C	-60 - 125		
T_j	Operating junction temperature	°C	-60 - 125		
MECHANICAL					
F	Mounting force	kN	80 - 110		
a	Acceleration	m/s^2	50 100	Device unclamped Device clamped	

Table 2. Characteristics

Symbols and parameters		Units	Values	Conditions		
On-state						
V_{TM}	Peak on-state voltage, max	V	1.5	T_j=25 °C; ITM—6300 A		
$V_{T(TO)}$	On-state threshold voltage, max	V	0.9	$T_j=T_{j\ max}$;		
r_T	On-state slope resistance, max	mW	0.080	0.5 I_{TAV} < I_T < 1.5 I_{TAV}		
I_I	Latching current, max	mA	1500	T_j=25°C; VD=12 V; Gate pulse: IG—2 A; di_G/dt>1 A/ms		
I_H	Holding current, max	mA	300	T_j=25 °C; VD—12 V; Gate open		
Blocking						
I_{DRM}, I_{RRM}	Repetitive peak off-state and Repetitive peak reverse currents, max	mA	300	$T_j=T_{j\ max}$; $V_D=V_{DRM}$; $V_R=V_{RRM}$		
$(dv_D/dt)_{crit}$	Critical rate of rise of off-state voltage[4], min	V/ µs	1000	$T_j=T_{j\ max}$; V_D=0.67V_{DRM}; Gate open		
Triggering						
Vgt	Gate trigger direct voltage, max	V	5.00 3.00 2.00	$T_j=T_{j\ min}$ T_j=25 °C $T_j=T_{j\ max}$	VD—12 V; ID—3 A; Direct gate current	
I_{GT}	Gate trigger direct current, max	mA	500 300 200	$T_j=T_{j\ min}$ T_j=25 °C $T_j=T_{j\ max}$		
V_{GD}	Gate non-trigger direct voltage, min	V	0.35	$T_j=T_{j\ max}$; V_D=0.67V_{DRM}; Direct gate current		
I_{GD}	Gate non-trigger direct current, min	mA	15.00			
Switching						
t_{gd}	Delay time	µs	1.50	T_j=25 °C; V_D=0.4V_{DRM}; I_{TM}=2000 A; Gate pulse: I_G=2 A; di_G/dt>1 A/ms		
t_q	Turn-off time, max	µs	500	dv_D/dt=50 V/ms; $T_j=T_{j\ max}$; I_{TM}=2000 A; di/dt=-10 A/ms; VR=100 V; VD=0.67 VDRM;		
Q_{rr}	Total recovered charge, max	µC	7500	$T_j=T_{j\ max}$; I_{TM}=2000 A; di/dt=-10 A/ms; VR=100 V		
trr	Reverse recovery time, typ	i s	60			
IrrM	Peak reverse recovery current, max	A	250			

THERMAL							
R_{thjc}	Thermal resistance, junction to case, max	°C/W	0.0050	Direct current		Double side cooled	
R_{thjc-A}		0.0110		Anode side cooled			
R_{thjc-K}		0.0090		Cathode side cooled			
R_{thch}	Thermal resistance, case to heatsink, max	°C/W	0.0010	Direct current			

MECHANICAL				
w	Weight, typ	g	2200	
Ds	Surface creepage distance	mm (inch)	44.60 (1.756)	
Da	Air strike distance	mm (inch)	15.70 (0.618)	

EXPERIMENTAL RESULTS

The experiment pulse thyristors with 2800 V repetitive impulse blocking voltage were produced using the above described technical solutions.

The thyristors had 100 mm silicon element, which was produced using the neutron-doped silicon wafers with 120 Ohm*cm electrical resistivity and 580 μm thickness. Topology of the gate is shown in Fig. 6. This topology ensures the optimal turn-on time of thyristor over the whole surface during commutation of impulses close in its from to half sine wave with 300-1000 μs width. Moreover, surface losses to alignment of the gate were minimized to about 14%, and the active surface of the thyristor element was about 55 cm2. All thyristors had disc housing.

Primary properties of thyristors are shown in Tables 1 and 2.

Figure 6: Topology of thyristor element.

Figure 7: Experimental thyristor switch for commutation of current pulse with 250 kA amplitude.

The new thyristors were used to create and test a switch for commutation of current impulses with extremely high amplitude.

The experimental thyristor switch consisted of 10 thyristors in series connection, Figure 7. The tests were held in R-L-C discharge circuit with 24 kV initial capacitor voltage, Figure 8. The current and voltage impulse forms is shown in Figure 9. During the testing, the experimen-

tal switch steady commutes current impulses with amplitude up to 250 kA and 4 kA/μs rate of rise.

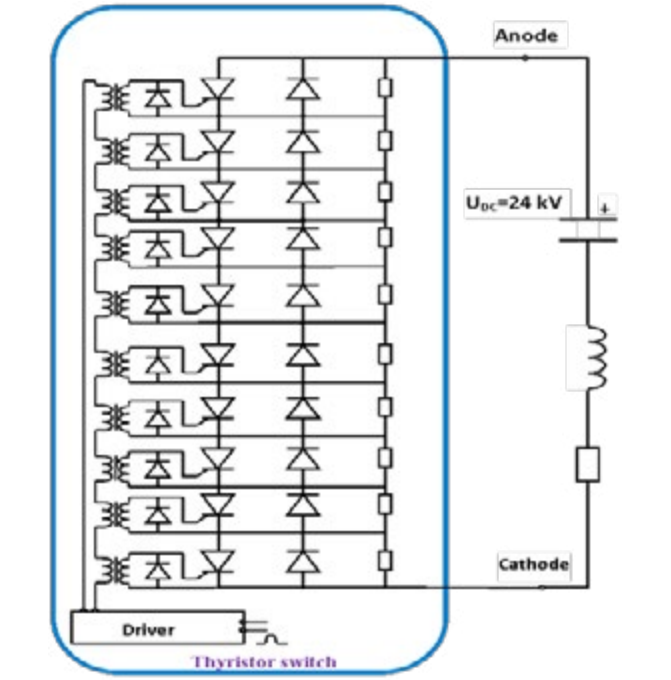

Figure 8: Discharge circuit

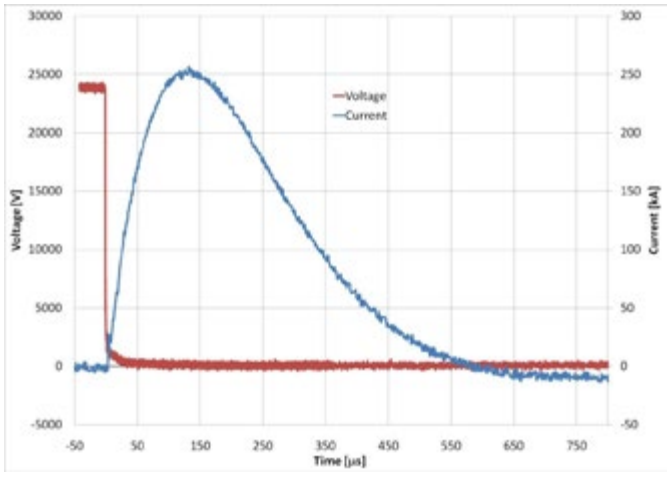

Figure 9: Oscilograph of current and voltage pulse commuted by the experimental switch produced on series connection 10 thyristors assembly.

CONCLUSION

There was developed the new generation of pulse silicon thyristors adapted to commute current impulses with extremely high amplitude, 100 – 1000 μs width. It was experimentally proved that it is possible for thyristor with 100 mm semiconductor element to commute current impulses with amplitude up to 250 kA and 500 μs width. New thyristors can be used to complete low cost solid state switches in pulse power supplies of high power electrophysical equipment.

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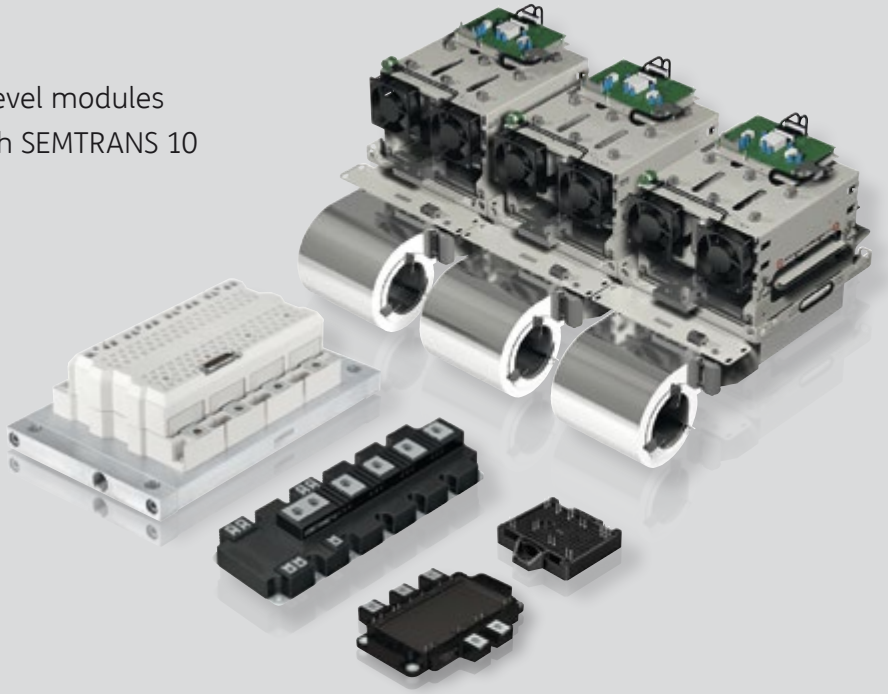

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CoolSiC™ MOSFET in Drives Applications

Offers Enhanced System Power Density and 50% Lower Losses, even with dv/dt Reduced to 5 kV/µs

By Michael Gadermann, Technical Marketing Manager, Infineon Technologies AG, Warstein

How to solve the dv/dt issue

Limiting the slew rate of inverter output voltages is a key requirement when working with motor drives, and is necessary to protect motors from premature aging effects. With IGBTs the most common approach is to use a higher value gate resistor to modify the voltage slope to the appropriate value.

However, if silicon carbide (SiC) MOSFETs are becoming more common, not all drives will use IGBTs. To determine whether this technique remains valid for the Trench-MOSFET (T-MOSFET), a laboratory inverter test was conducted to obtain better insight into the usability and advantages of SiC power semiconductors in drive applications [1].

Due to its intrinsic behavior, the SiC T-MOSFET is able to switch much faster than common IGBT devices. The SiC T-MOSFET can easily reach a slew rate of 50 kV/µs, which causes significant problems for a standard motor unless additional measures are taken.

Especially when combined with long motor cables, the resulting steep voltage slopes and high voltage peaks at the motor terminals can cause premature failure of the motor's isolation. They can also lead to increased currents in the motor bearings. All of these motor components are stressed by very short rise times of the input voltage. In order to use standard motors without damage, the switching speed of the SiC T-MOSFET needs to be limited. Due to the excellent controllability of these devices, the required maximum dv/dt of 5kV/µs can simply be achieved by employing a suitable gate resistor.

A common way to select a proper gate resistor appropriate to the required switching speed for the SiC T-MOSFET is to consider the turn-on event at 10% of the nominal module current and a junction temperature of 150°C. The switching speed during turn-off rises with increasing load current and therefore turn-off gate resistance is determined at the nominal current. To achieve 5 kV/µs, a gate resistor value of 15 Ω for turn-on and 30 Ω for turn-off was found to be a good choice during the laboratory inverter test.

Figure 1 shows the voltage slope (dv/dt) controllability of the SiC T-MOSFET. As can be seen, the switching characteristic can be controlled over a wide range at turn-on and turn-off. The significantly better controllability of the SiC MOSFET is a major benefit over IGBTs.

Features of the CoolSiC™ Trench-MOSFET

Infineon introduced the novel 1200 V CoolSiC™ MOSFET in 2016, featuring high switching performance, low specific RDS,on combined with a highly reliable gate oxide. Compared to other SiC based transistor solutions, the CoolSiC™ T-MOSFET copes very well with the commonly-used and proven +15 V/-5 V gate drive circuitry that is also well-known from silicon IGBT-based converter setups. As such, there is no need to develop new or special gate drivers for CoolSiC™ MOSFETs. Additionally, the internal body diode of the CoolSiC™ MOSFET can be operated as a Free-Wheeling Diode (FWD) in a half-bridge with an interlock time. This diode features very low dynamic losses. The typical interlock times for SiC are a few hundred nanoseconds long and, as a result, the higher forward voltage drop can be tolerated. The electrical characteristics of SiC T-MOSFETs offer further advantages in comparison to silicon IGBTs. As an example, due to the unipolar structure of a MOSFET, no minority charge carriers are involved during the switching process leading to significantly reduced switching losses. Additionally, the absence of a knee voltage of the transistor, together with a low on-state resistance, results in significantly reduced conduction losses, especially at low or partial load.

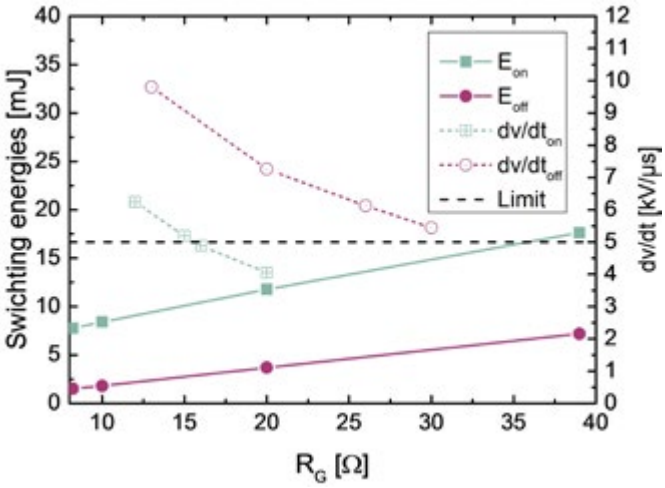
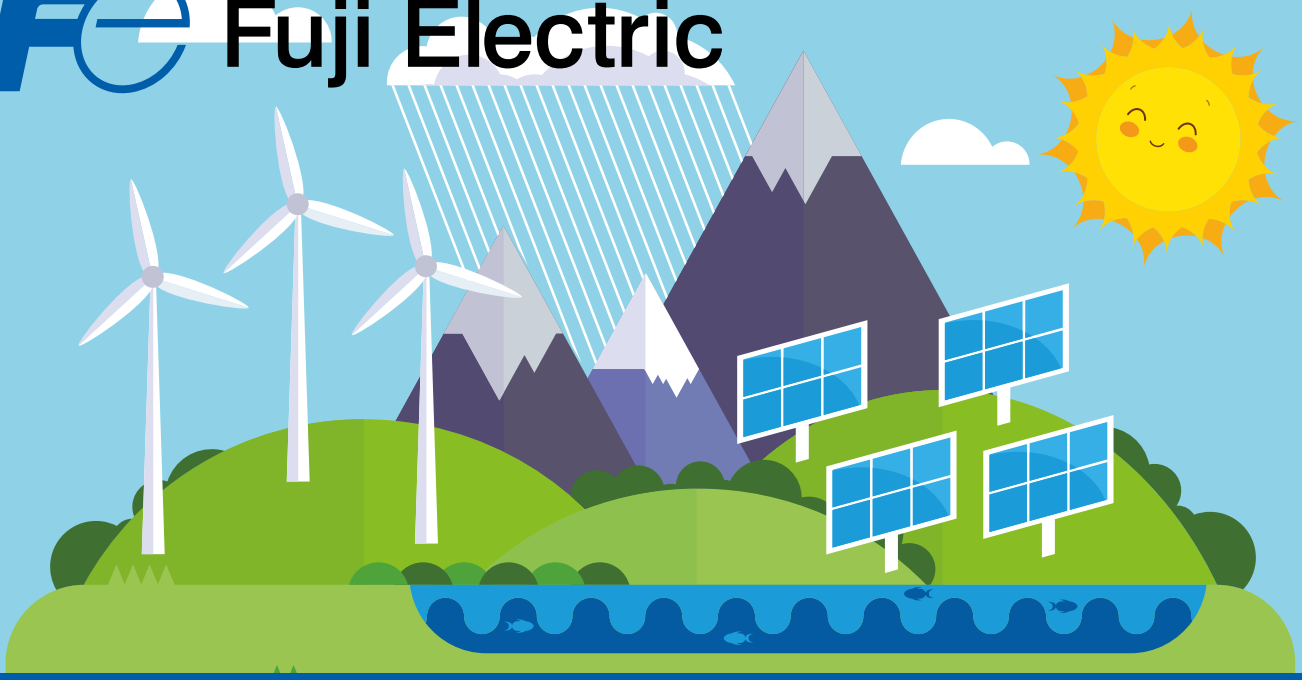


Figure 1: The excellent controllability at turn-on and turn-off is one of the key advantages of the CoolSiC™ MOSFET, dv/dt determined between 10% - 90% VCE at 150 °C and 10 A (turn-on) and 100 A (turn-off)

Power losses compared to conventional IGBT technology

A comparison of power losses between recent IGBT technology and the SiC T-MOSFET gives the results shown in Figure 2. The IGBT power module FS100R12KT4 was evaluated against an engineering sample of the new SiC module FF11MR12W1M1_B11 in a double pulse test, with both devices switching at moderate switching slopes with a maximum value of 5 kV/µs. The chart of the derived power losses clearly shows the advantage of the SiC device.

Fuji Electric



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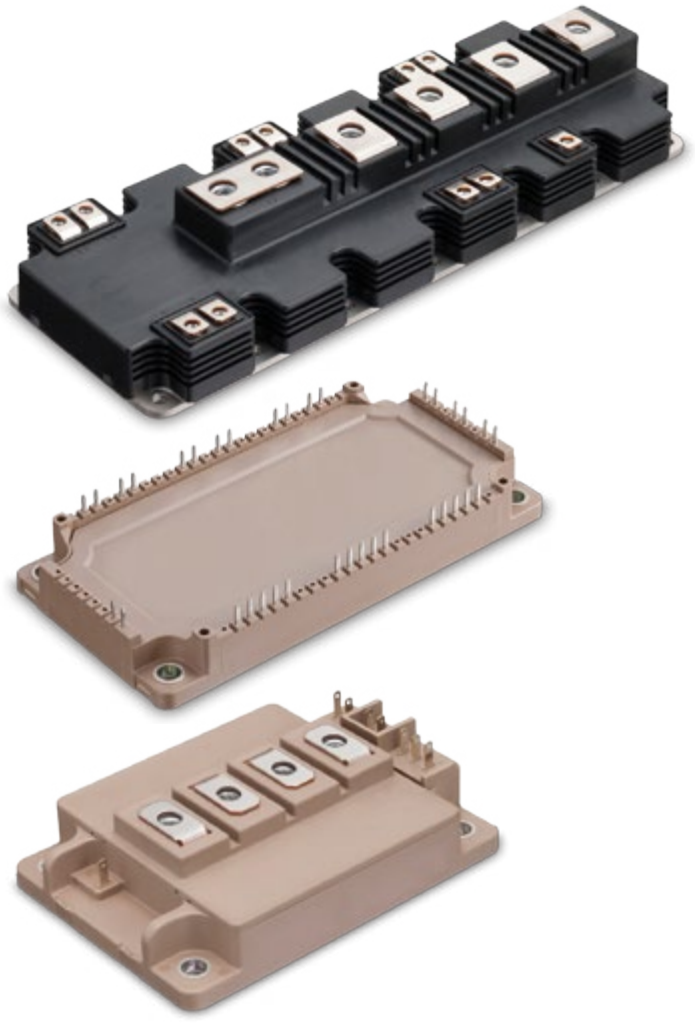

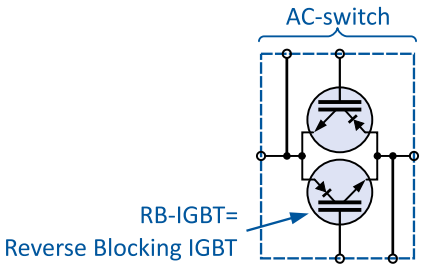

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Even at the same dv/dt of 5 kV/µs the significantly decelerated CoolSiC™ MOSFET has over 50% lower switching losses when compared to the IGBT. This is due to the MOSFET having no tail current and the diode having a very low reverse recovery current. The conduction losses were also reduced by around 40% due to the lower on-state resistance (RDS,on) compared to the saturation voltage of the silicon IGBT and silicon FWD, leading to an overall reduction in inverter power losses of 53 % at a PWM switching frequency of 4 kHz and a reduction of 58 % at 8 kHz.

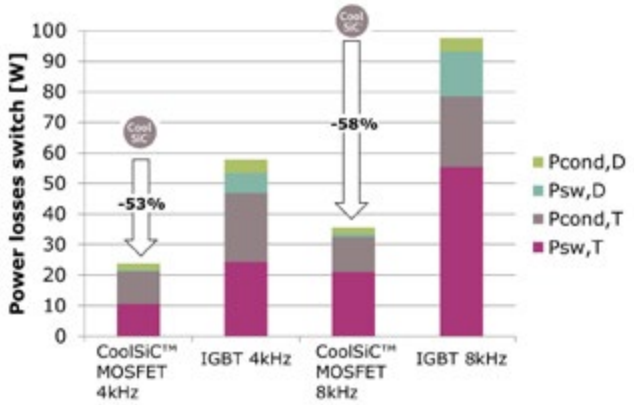

Figure 2: Even at reduced dv/dt of max. 5kV/µs the CoolSiC™ MOSFET features significantly lower losses than conventional IGBTs with the same current rating

With these impressive results it is possible to reduce the heatsink size significantly and therefore reduce the weight and size of the power converter dramatically.

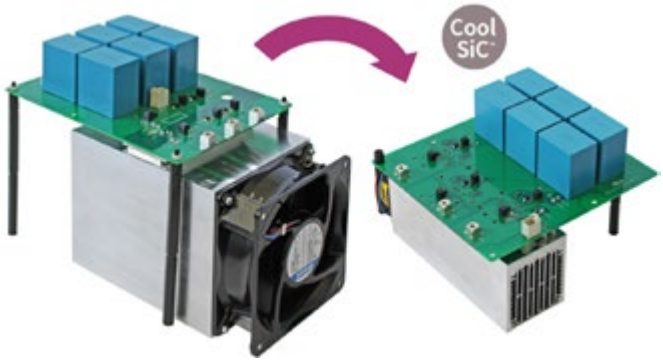

Figure 3: The loss reduction with SiC at a dv/dt of 5kV/µs enables reducing the heatsink volume by 64% while maintaining the same heatsink temperatures (switching frequency 4 kHz)

Figure 3 depicts suitable heatsinks along with inverter setups for two power module concepts that utilize the SiC T-MOSFET switch (right) and a typical IGBT module with the same current rating (left). These devices were evaluated in the laboratory inverter test under application-relevant conditions. Even with a much smaller heatsink, the 22 kW SiC inverter shows a lower maximum heatsink temperature in the test at 8kHz switching frequency - as can be seen in Figure 4.

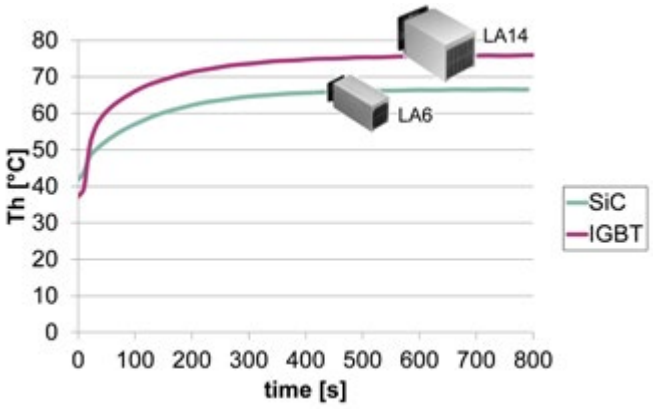

Figure 4: Even at reduced heatsink size the SiC T-MOSFET design features a lower heatsink temperature when operating at 8kHz switching frequency

Energy and cost savings in common applications

During the investigations of the 22 kW SiC inverter, that replaces an equivalent IGBT inverter, the potential energy savings were calculated, assuming a pump application. Considering partial load operation, with the assumption of 50% speed and 25% torque producing current, as described in EN 50598-2, the potential savings can be calculated to be 78W, whereas in the operation point of nominal speed and torque the savings would account for 195W.

Assuming a load profile with a split of 50% reduced speed and 50% nominal speed operation over time this would result in a saving of 1196kWh per year. Consequently, the maximum obtainable cost savings can be calculated to be 120€/year per inverter for typical industrial consumers with an energy price of 0.10 €/kWh. In addition to that the effort for the switch cabinet air conditioner can be reduced accordingly.

These savings are possible due to the linear on-state characteristics and the lower switching losses of the CoolSiC™ MOSFET that result in a significantly improved loss saving potential, especially in the range of partial load, which is the most common operating mode of most variable speed drives.

Reference

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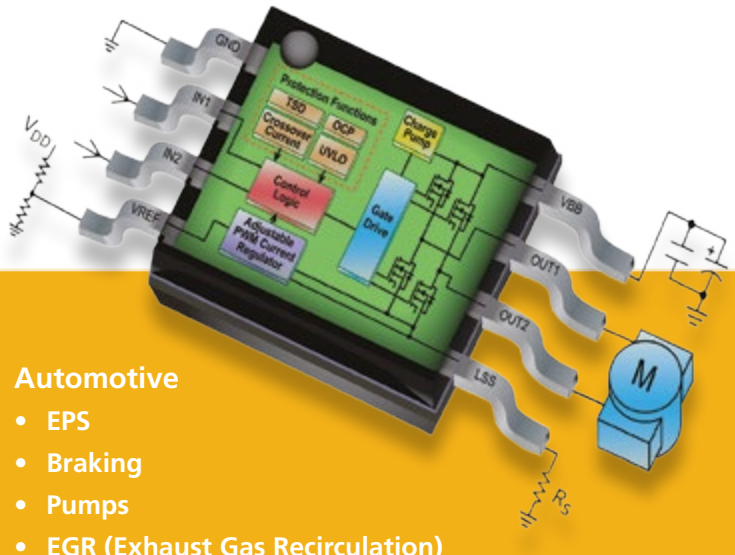

Key Applications:

Industrial/Consumer and Computer

- Robotic vacuums
- Gaming electronics
- Inkjet/laser/POS/ Label printers
- Copiers/Scanners
- Vending and ticketing machines

Automotive

- EPS
- Braking
- Pumps
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Advantages of Pre-Applied Thermal Interface Material for Power Modules

There are various interconnection options for all standard power modules—solder or press-fit pins, a selection of pre-applied thermal interface materials, and much more. The latter option, the thermal interface material or TIM for short, is rather important as it can have a—pardon the pun—thermal impact on the module's thermal behavior since it has a huge influence on the heat transfer from the power module to the heat sink.

By Mirko Haardt, Field Application Engineer, Vincotech

Conducting a great deal of research in this area, Vincotech tries to find even better ways to meet customers' needs. Recent insights have prompted us to add two new options to our range, silicone-free thermal grease and a high performance TIM.

Power modules convert electrical power from DC to DC, DC to AC, or AC to DC. This is inevitably a loss operation. In every conversion, some electrical energy turns into thermal energy, a little of which lost even in cases where efficiency approaches 100 %. Usually this loss amounts to around 1 % to 8 % of overall losses. This heat has to be dissipated to protect the device's electronic components against thermal damage, which is done by bonding power semiconductors to heat sinks.

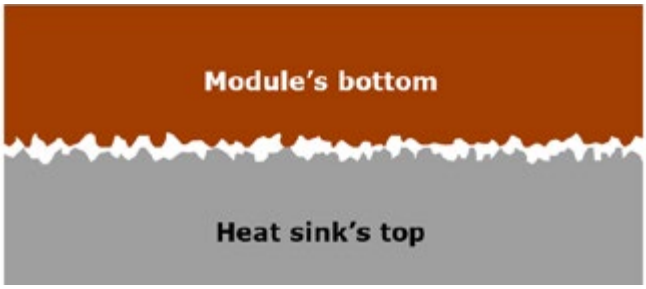

Figure 1: A power module's base connected to a heat sink

The best way to join the two is to apply thermal interface material (TIM) to the junction. It fills cavities on the power module and levels out any unevenness on the heat sink. The TIM complicates things by adding another layer to the thermal model. However, components' surfaces are never perfectly smooth and level, so TIMs are a necessary evil. They offer a proven way of achieving a proper bond between the top of the heat sink and the bottom of the power module.

Thermal grease basically consists of two components; a carrier material and a filling material which is mainly responsible for the thermal conductivity. There are several TIM parameters having impact on the heat transfer through this thermal layer. The quality of the conductivity is highly dependent e.g. on the size, shape and distribution of the filling material. As an example, Figure 2 shows two TIMs loaded with different grain sizes. The smaller grains are able to fill also small surface irregularities to reduce the contact resistance and the fill factor is even higher which improves the R_{th} of the TIM layer.

It is no secret that applications are getting more sophisticated. Power assemblies and thermal grease must evolve and improve to meet the demand for smaller footprints, greater power and requirements in special application fields. E.g. silicone-based TIM is forbidden in many automotive environments. Several manufacturers heeded the call. Vincotech tested their products and is now able to offer a selection of pre-applied thermal greases to meet these demands.

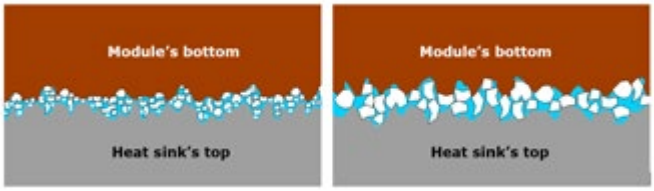

Figure 2: Comparison of two TIMs with different grain sizes

As its name would suggest, the greatest benefit of pre-applied TIM is that you do not have to apply the grease. Vincotech does this for you. The advantages are twofold: For one, this saves time and resources by leaving you with one station fewer on the production line. For the other, the TIM's layer thickness and quality never vary. Even now, the standard TIM is often applied by hand with a roller, brush or putty knife. But no one is perfect. Even the most conscientious worker will have an inattentive moment or an off day. The screen-printing process, in contrast, always applies a uniform layer of thermal grease to assure the highest quality in every pass. All TIMs described below are screen-printed.

Property	Value
Density at 25 °C	2.1 g/cm³
Dielectric strength	10 kV/mm
Thermal conductivity	0.81 W/m K
Color	White

Table 1: Standard TIM parameters

Standard thermal grease

Vincotech pre-applies Wacker® Silicone Paste P 12, a standard TIM widely used in industry applications. It comes highly recommended

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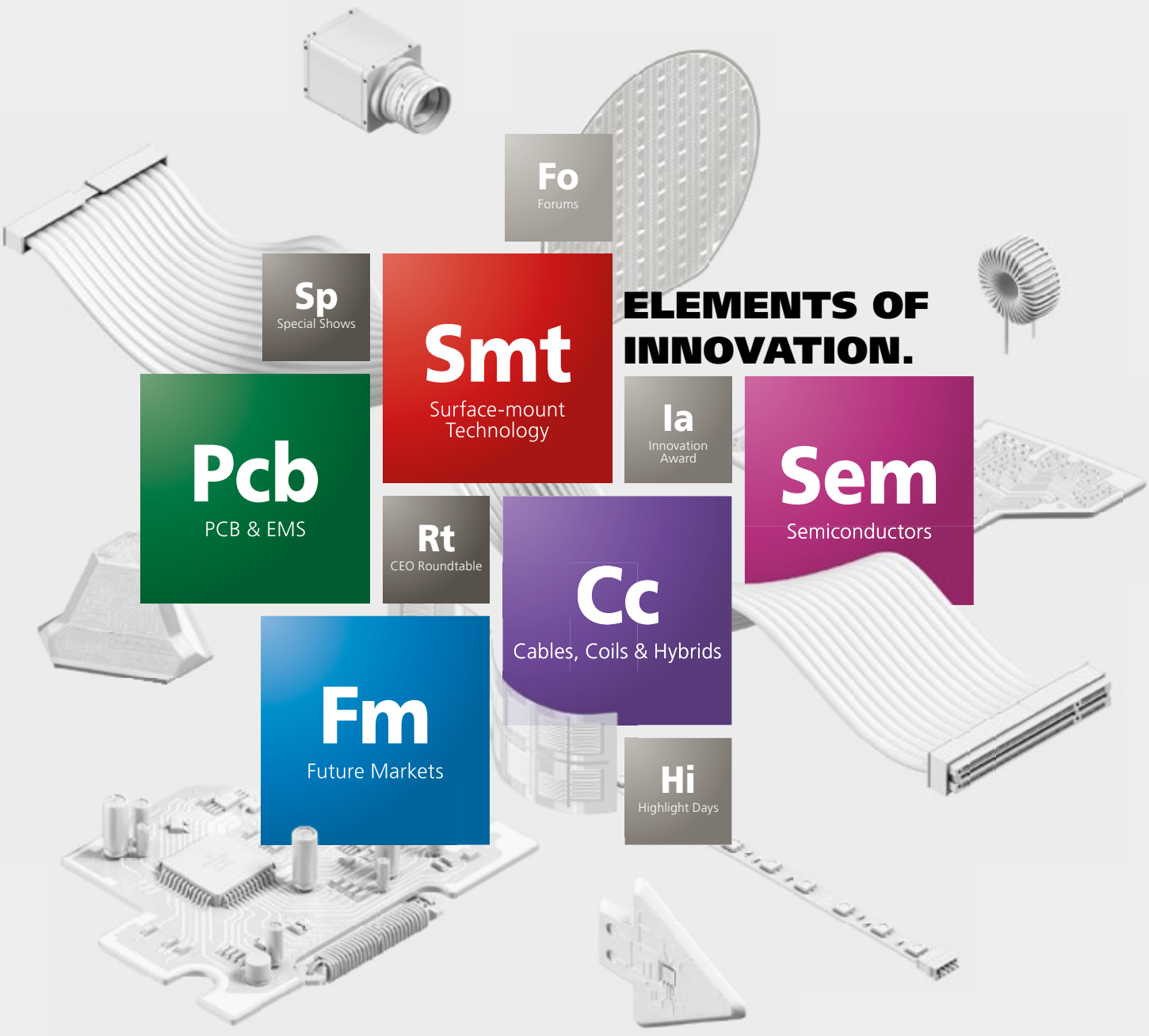

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as a stand-in for Phase Change material, the details of which are described below. Some housings such as standard MiniSKiiP® power modules are incompatible with Phase Change Material due to too thin or too brittle substrate materials. So this silicone paste is a good substitute that was qualified years ago and has proven its merits in countless applications.

High Performance Thermal Paste

The latest member in Vincotech's TIM family is the high performance thermal paste TC-6000HP which was just released; it is a silicone compound for exclusive use on MiniSKiiP® power modules. The high performance thermal paste is a standard thermal grease but with optimized filling material. The R_{th} is reduced more than 30% compared to standard TIM pre-applied on MiniSKiiP® power modules. This consequently results in a higher power density per device.

Property	Value
Density at 25 °C	4.2 g/cm³
Dielectric strength	3 kV/mm
Thermal conductivity	2.5 W/(m K)
Color	Greenish yellow

Table 2: High performance TIM parameters

Silicone-free thermal grease

Silicone is a no-go for many applications. To provide a non-silicone option, Vincotech investigated and qualified a Müller Ahlhorn TIM for its MiniSKiiP® housings. Thermigrease® TG20032 is an alternative to Wacker® Silicone Paste P 12.

Property	Value
Density at 25 °C	2.1 g/cm³ to 2.3 g/cm³
Dielectric strength	20 kV/mm
Thermal conductivity	2.5 W/(m K)
Color	Blue

Table 3: Silicone-free TIM parameters

This silicone-free thermal grease has the same behavior and similar thermal conductivity like the standard TIM even though the datasheet value thermal conductivity is much better. Due to the kind of filling material the performance is similar to Vincotech's standard thermal grease. But it is easy to distinguish—it is blue—to rule out any mix-ups when more than one TIM is used for one type of power module on the production line.

Phase Change material

Rolled out by Vincotech years ago, Phase Change material is the alternative to standard thermal grease. Many customers have since opted for Phase Change material, and their numbers are growing. With good reason: Experience has taught our customers and us that this reliable material has some key advantages over standard TIMs.

Phase Change material's greatest advantages are that it achieves much higher thermal conductivity than most standard TIMs and excellent long-term stability without any pump-out effect. Its stiffness below 45 °C and applicableness in standard solder profiles makes it very easy to use in every production line. The honeycomb pattern's spreads uniformly as soon as the case temperature rises above 45 °C and the module is mounted to a heat sink simultaneously, so that pressure is also applied to the material.

This material is recommended for all flow housings with standard Al2O3 DCBs and some AlN-based modules.

Property	Value
Density at 25 °C	2 g/cm³
Thermal conductivity	3.4 W/(m K)
Phase change temp.	45 °C
Viscosity above phase change temp.	thixotropic
Color	Grey

Table 4: Phase Change Material parameters

Several technical papers have described this material's benefits and behavior. The application note "Power Modules with Phase-Change Material," for example, is downloadable on Vincotech's new homepage at https://www.vincotech.com/support-and-documents/technical-library.html.

MiniSKiiP® with pre-applied std. TIM

MiniSKiiP® with pre-applied silicone-free TIM

flow 1 with pre-applied Phase Change Material

Figure 3: Vincotech power modules with pre-applied TIM

Protection caps

Protective caps are available on request for selected flow housings to ensure that the material cannot be touched even when the case temperature is above 45 °C, for example, right after soldering. Besides they are a useful dirt protection during storage or transport as long as the subassembly of pcb and power module is not mounted to the heat sink.

Figure 4: Vincotech TIM protective cap for flow modules

MiniSKiiP® housings with pre-applied thermal interface material

Phase Change Material was long an option limited to Vincotech flow housings. MiniSKiiP® housings' DCB (0.38 mm, Al2O3) was too thin for this material to be a viable alternative, so the standard thermal grease was the only choice of pre-applied TIM available. With the benefit of a recently developed, advanced substrate technology, there are now three TIM options for standard MiniSKiiP® housings and one additional solution for MiniSKiiP® modules with this new substrate technology on offer.

The three options for MiniSKiiP® housings with standard Al2O3 DCBs are the tried-and-true Wacker® Silicone Paste P12, Müller Ahlhorn's TG20032 silicone-free paste and the high performance TIM TC-600HC. The fourth option for our MiniSKiiP® line comes with a new alternative to the standard DCBs, an Si3N4 AMB, short for silicon nitride active metal brazing.

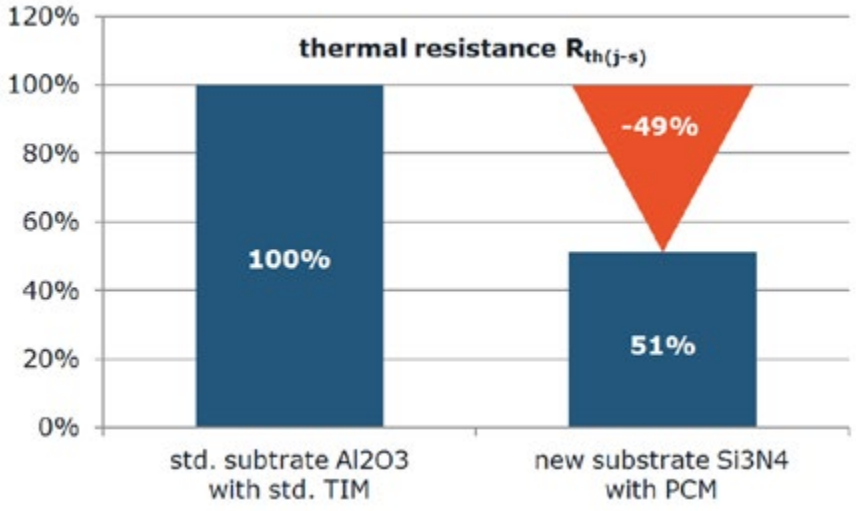

Figure 5: R_{th} comparison between standard substrate with pre-applied standard TIM and new silicon-nitride substrate with Phase Change Material. Both measured on MiniSKiiP 3 sixpack.

Thermal Interface Material	Recommended housing
Standard silicone-based TIM Wacker® Silicone Paste P12	• MiniSKiiP®
Silicone-free TIM Müller Ahlhorn TG20032	• MiniSKiiP®
High performance TIM TC-6000HP	• Exclusively for MiniSKiiP®
Phase Change Material Henkel/Loctite PSX-Pm	• Vincotech flow housings with Al_2O_3 or baseplate • MiniSKiiP® with Si_3N_4 AMB • others on request

Table 5: TIM overview

This new AMB's remarkable thermal conductivity is four times greater than Al2O3 DCBs'. Equally impressive is its mechanical robustness, which enables Vincotech to pre-apply Phase Change Material for the first time to MiniSKiiP® power modules on an industrial scale. This combination's thermal resistance is 40+ % lower than that of the standard solution with an Al2O3 DCB and the usual TIM. What's more, this silicon-based substrate's low expansion rate vastly improves power modules' cycling capability.

Conclusion

If you are seeking a forward-looking partner who provides a range of solutions tailored to your needs, Vincotech is the right choice. The company always endeavors to find reliable new ways to get the job done—not only in terms of housings and chips, but also with options such as pre-applied thermal grease.

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Keeping the Lights On

By Gil Shavit, Chairman, GenCell

Adapting to a Changing Landscape
In the last few months, the world has seen significant changes – new heads of state in several countries; Britain's exit from Europe; shocking terrorist attacks and cybercrime of international proportions. Why do I mention these things? Because they all have an impact on our utilities markets and demonstrate how integral our industry is to the health of our nations.

Due to strict regulation in many countries, utilities have been required to invest heavily in their operations at a time when electricity sales are generally flat or in decline. That's not to suggest that these utilities aren't profitable, but it does add an additional layer of complexity to their businesses.

In North America for instance, Obama's Clean Power Plan saw considerable amounts of money spent on renewable energy sources such as solar and wind. There was also additional pressure placed on utilities to meet a new set of governmental standards, but with President Trump's recent decision to remove the US from the Paris climate agreement, the impact of this decision is not yet clear.

Add these challenges to more fundamental initiatives to upgrade and better balance the grid, utility businesses of 2017 have significant challenges to meet. What's more, the introduction of smart meters and a new consumer awareness to energy consumption has led many leading utility companies to investigate new innovative technologies to support their businesses.

Figure 1: The delivery of electricity in the US relies on an aging and complex patchwork

The Cost of Grid Unreliability
One of the most critical challenges is to improve grid reliability. That said, the grid can go down for many reasons and not all of them are avoidable.

In the 2017 Infrastructure Report Card, the American Society of Civil Engineers assigned a "D+" to the US energy infrastructure. It stated that the delivery of electricity in the US relies on an aging and complex patchwork of systems with various ownership and stakeholders. And with the power grid at full capacity, maintenance is paramount.

In 2015, Americans experienced a reported 3,571 of total outages, with an average duration of 49 minutes. Momentary blackouts cost the US economy $60 billion, while sustained blackouts cost $50 billion, with some lasting as long as 8 hours or more.

Keeping Critical Systems Online for Longer
Whilst electricity blackouts are likely to stay with us for some time yet, many utilities are now turning to alternative technologies, such as fuel cells, to provide immediate, reliable and long-term backup power to mitigate the challenges of power outages.

By installing fuel cell solutions like our GenCell G5 long-duration UPS at end-customer sites, utilities can provide clean backup power, with the added ability to push electricity back to the grid enabling improved load balancing and higher quality of service (QoS). Providing important piece of mind and utilizing the technologies immediacy to start in-phase, fuel cells are ideally suited to back-up applications. Supporting the modern 'Energy Cloud', fuel cells are also an important contributor for local peak demand response or 'Peak Shaving'.

Utilities are also installing fuel cells to backup other critical systems such as internal communications, command-and-control rooms and substations. These fuel cells, like our GenCell G5rx, are uniquely designed for installation at utility substations, operating as a direct source of backup power or to recharge back-up battery rooms and keep them at full power. In the case of our own solution, for up to 10 times longer.

Fuel cells achieve this by enabling substations to keep their breakers and controls in an operational mode, so that utilities can quickly restart power and minimize distribution time to end-users once the grid recovers.

But What is a Fuel Cell?
First invented in 1839 by William Grove, a fuel cell is an electrochemical energy conversion device that produces electricity by combining hydrogen and oxygen into water. Like batteries, fuel cells convert potential chemical energy into electrical energy and generate heat as a by-product.

Figure 2: A GenCell System

But, batteries store chemical energy within them - rather than being self-generated - which means that they can only operate for a limited duration until discarded or recharged. If supplied with an unlimited amount of fuel, fuel cells can continuously generate electricity (hydrogen) and oxygen.

There are five primary types of fuel cells:

- Alkaline Fuel Cells (low temperature)
- Proton Exchange Membrane Fuel Cells (low temperature)
- Phosphoric Acid Fuel Cells (medium temperature)
- Molten Carbonate Fuel Cells (high temperature)
- Solid Oxide Fuel Cells (high temperature)

Each type of fuel cell has its own inherent strengths and weaknesses that make them more suitable for specific markets and applications.

Our Alkaline fuel cell technology (AFC), which is being adopted by utilities, was originally developed for space applications where reliability and durability are essential requirements. But to achieve those key attributes, space applications featured Platinum and Palladium electrodes and other costly components. As a result, alkaline fuel cells were unaffordable for earth-bound power generation markets.

This is where our team at GenCell made several important breakthroughs. Having completely remodeled the traditional AFC system, redesigning many components using less costly materials, we were able to eradicate platinum as an electro catalyst. While maintaining the life and efficiency of the AFC, removing the need for platinum has allowed us to break the cost barrier that has previously prohibited the widespread adoption of this technology.

In addition, our unique CO2 scrubbers enable our fuel cells to use the O2 found in ambient air. For utility companies, these innovations enable our GenCell G5rx to provide them with all the sought-after benefits of fuel cells, but at a price point that is competitive with UPS batteries and diesel generators.

Extending Back-up Power, Reducing Costs and Environmental Impact

Why are fuel cells important? Well, as a completely clean power generation process, fuel cells are very attractive to utilities not only from a financial perspective in minimizing downtime, but also in supporting their drive to become more sustainable.

Quite simply, fuel cells produce zero-emissions, are silent and vibration free. They are also suited to both extreme environments and urban settings, so they are highly flexible. What's more, they are extremely reliable, require very low maintenance and can be operated remotely.

Fuel Cell Adopters

So, fuel cells are clearly a very compelling technology for utilities, but who's using them?

Earlier this year, San Diego Gas & Electric (SDG&E), part of Sempra, a leading North American energy company, announced that it had been working alongside us to test how fuel cells could contribute to their efforts to be the cleanest, safest, most reliable energy company in America.

In addition to SDG&E, another notable and recent adopter of fuel cell technology includes Israel's national utility provider, IEC (Israel Electric Company). IEC provides roughly 85% of Israel's electricity.

With many other utilities around the world adopting or seriously evaluating the use of fuel cells within their operations, it's clear that this technology will be an important solution to one of the industry's key challenges.

Overcoming Barriers to Success

But there are still barriers to wide and rapid fuel cell adoption, and it's mainly an issue of education. When talking to prospects, our first job is often to correct what they think they know by demonstrating that the technology employed today is vastly different to that of the 1970's and 1980's. With previous commercialization issues now resolved, we show them that the modern fuel cell is both robust and affordable.

This type of conversation is no doubt common to all fuel cell manufacturers. But for many utility companies around the world, the fuel cell business case is so compelling that after investing a little time to understand it, the cost of a fuel cell to minimize the impact of grid downtime becomes an obvious and sensible decision.

Fuel Cells for the Mainstream

Companies of all types and sizes are already incorporating hydrogen and fuel cells into their businesses. Leading companies such as Apple, Verizon and Coca-Cola are using stationary fuel cells to generate power. Toyota, Honda and Hyundai are coming to market with hydrogen fuel cell powered vehicles for consumers and trucking.

Metropolitan areas and airports are beginning to migrate to emission-free hydrogen fueled buses too. In the USA, the UK and Europe, hydrogen refilling stations are being built, overcoming the challenges of hydrogen distribution for consumers. Indeed, the US Department of Energy notes that hydrogen and fuel cells are on the verge of a "tipping point".

As we transition into a greener economy increasingly fueled by hydrogen, fuel cell solutions for backup and power-on-demand are overcoming the significant weaknesses of other clean technologies such as solar and wind. And thanks to cutting edge introductions that have solved previous fuel cell affordability, this technology is now also complementing or even replacing, legacy backup solutions such as batteries and diesel generators, in use at utilities throughout the world.

About GenCell

GenCell manufactures, sells and services fuel-cell-based power solutions that provide a reliable, scalable source of 5kW electricity. Fueled by hydrogen, the clean energy of the future, the GenCell G5 long-duration UPS (uninterruptible power supply) provides backup power for telecom, homeland security, healthcare and niche industrial markets. The GenCell G5rx utility backup power solution operates as a direct source of backup power or to supplement legacy backup battery systems that provide only 6-8 hours of power and includes a shelter that is resistant to EMPs and high voltage. Headquartered in Israel, GenCell has a regional presence and a distribution and support network in North America, Latin America and Europe.

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Household Energy Storage System's Power Solution

The intelligent information age greatly increases electricity demand, which, in return, pressures people into seeking for green power generation due to the severe environmental pollution and energy consumption. Solar PV power generation is expected to alleviate the pressure. With government's policy support and less cost of power generation, energy storage systems are brought in tens of thousands of households. For the entire household energy storage system, MORNSUN provides a complete power solution to simplify customer's design and increase system's reliability.

By Morgan Shao, FAE, Mornsun Guangzhou Science & Technology Co., LTD.

Introduction of household energy storage system

With the ongoing development of The Million Solar Roofs bill (the United States) and Energiewende (known as "energy transition", Germany), household energy storage system is widely introduced in over 50 countries worldwide, especially when the governments give high subsidies to families whoever apply solar PV power generation. As a result, most families not only achieve self-sufficiency of household electricity but also store excess electricity. The market demand for household energy storage system is growing.

The household energy storage system is similar to a miniature energy storage power station, while its operation is free from the pressure of the utility. Battery pack in the system is self-charged during the trough period of using electricity, and discharges it during the peak period of using or powering off electricity. In addition to using as an emergency power supply, the system is able to balance the electricity load, thereby saving household electricity cost.

Current market demand for household energy storage system more relies on the need for emergency power supply. However, in the eyes of professionals in the industry, the household energy storage system market is bright and promising. It combines new energy power generation system, e.g. solar, and promotes the new energy on the other hand, contributing to building intelligent power grid.

Structure and components of household energy storage system

Household energy storage system is currently divided into two kinds, grid-connected and off-grid.

Grid-connected household energy storage system is mixed-powered by solar and the energy storage system, including five parts: solar array, grid-connected inverter, BMS management system, battery pack and AC load. When the utility works normally, the solar grid-connected system and the utility together power the load. When the utility powers off, the energy storage system and the solar grid-connected system together power the load. The grid-connected household energy storage system is divided into three working modes. Model I, solar provides energy storage and powers the utility. Mode II, solar provides energy storage and powers part of residential electricity. Mode III, solar only provides energy storage. Grid-connected household energy storage system is as shown in Figure 1:

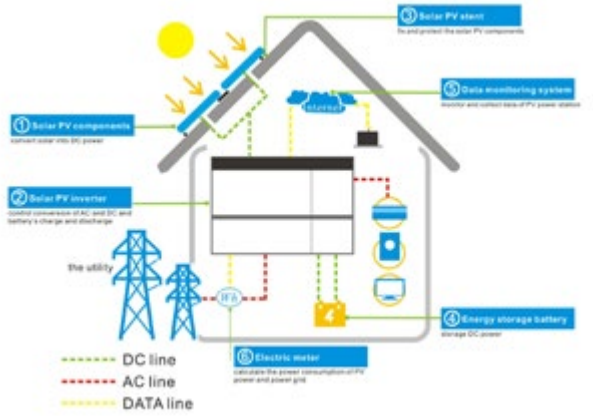

Figure 1: Grid-connected household energy storage system (source: www.fortunenergy.com)

Off-grid household energy storage system is independent, without any electrical connection to the grid. Therefore, the whole system does not need grid-connected inverter except PV inverter. The off-grid household energy storage system is also divided into three working modes. Model I, solar provides energy storage and powers residential electricity in sunny days. Mode II, solar and energy storage battery power residential electricity in cloudy days. Mode III, energy storage battery powers residential electricity at dusk and in rainy days. Off-grid household energy storage system is as shown in Figure 2:

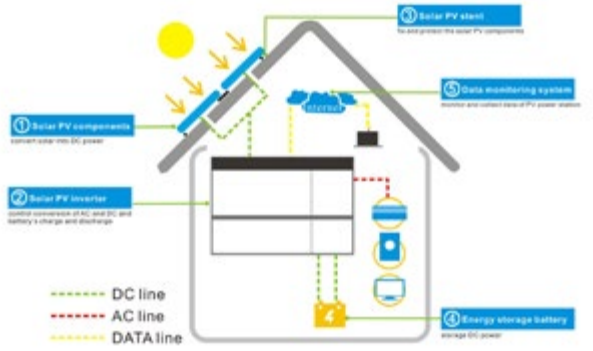

Figure 2: Off-grid household energy storage system (source: www.fortunenergy.com)

In summary, current demands for energy storage equipment mainly are BMS management system, PV grid-connected inverter and energy storage inverter. Combined the demands with the safety isolation requirement of PV system's unit circuits, MORNSUN puts forward a complete power solution of control unit.

Power Solution for BMS management system

Battery is the core energy storage device of the system and needs to be monitored online status in real time, so the importance of BMS is self-evident. In the BMS management system, BCU real-time communicates with CAN bus and BMU to get monomer voltages, cabinet temperature, insulation resistance and others, with current sensor to collect charge and discharge current and dynamic calculation SOC and with touch screen to display relevant data. The BCU calculates and analyzes all the information of the battery pack and then intelligently manages the system, communicating with the independent CAN bus and achieving the secondary protection of charge and discharge through a relay. The latter ensures an effective isolation for strong electricity and weak electricity, meets customer's demand for diverse security control and guarantees stable and efficient operation of the system.

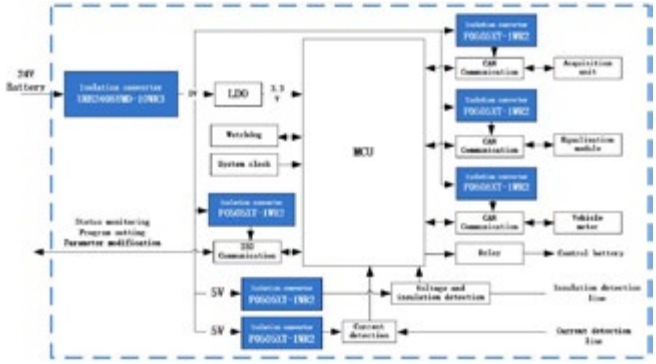

Figure 3: Power Solution for BMS management system

As shown in Figure 3, isolation voltage conversion is the main core of power solution for BMS management system in the energy storage system. Main control unit is mainly based on 24VDC system, and the power of the whole main control unit is less than 5W. Therefore, URB2405YMD-10WR3 offering 5VDC output voltage is recommended to power F0505XT-1WR2 and LDO. The LDO converts 5VDC into 3.3V output voltage to power MCU. 6PCS F0505XT-1WR2 in the system are used to power four CAN modules, voltage detection circuit, insulation detection circuit and current detection circuit, and isolate power circuit, signal circuit and communication module at the same time to reduce interference and improve the stability and reliability. In addition, MORNSUN automotive-grade power supply CF0505XT-1WR2 is widely used in automotive BMS system.

Power Solution for solar PV inverter monitoring unit

Solar PV components converge energy and inverter converts DC into AC. The process of the inverter needs to be monitored, controlled and communicated so as to ensure its voltage to meet the requirement. This monitoring unit can directly get power from the utility.

As shown in Figure 4, LH series directly gets power from the utility and converts it into 24V output voltage, which is converted into 5VDC output voltage by non-isolated switching regulator K7805-500R3. B0503XT-2WR2 outputs 3.3V to power the MCU with isolation function. Isolated high speed TD501D485H can inhibit electromagnetic interference and rise the ground loop's resistance to protect the system circuit from external network. In addition, MORNSUN develops an isolated driver QP12W08S-37 integrating DC/DC power supply, specialized for full-bridge IGBT, to simplify the design of customer's driven-control circuit and improve the reliability.

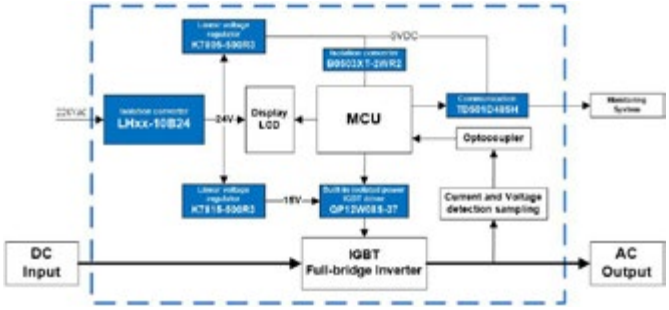

Figure 4: Power Solution for solar PV inverter monitoring unit

Power Solution for solar PV grid-connected inverter monitoring unit

Solar PV grid-connected inverter, also known as bi-directional energy storage inverter and controller and inverter integrated machine, consists of AC-DC unit, DC-DC unit, control unit, communication unit and unit of transfer relay. Bi-directional energy storage inverter is powered from two kinds of power supply equipment. One is from the utility, and the other from the solar panel.

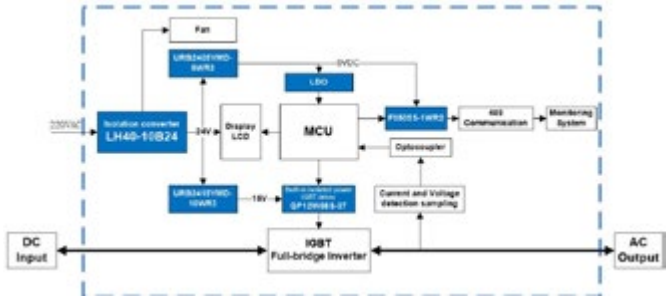

Figure 5: Power Solution for solar PV grid - connected inverter monitoring unit

As shown in Figure 5, the power selection of AC/DC Converter should mainly take the power of main control board and fan into account. The equipment power in above system is 15KW. AC/DC Converter LH40-10B24 offering 24V output voltage is recommended to power the fan and the main control board. For the main control board, it's recommended to use R3 DC/DC Converters URB2415YMD-10WR3 to power IGBT driver and URB2405YMD-6WR3 to power MCU and communication module. URB_YMD-6/10WR3 series apply fully automated production process, greatly reducing the labor costs. With superior performance, ahead of the peer level and high cost-effective, they fully meet the overall cost demand of solar PV industry.

MORNSUN power supplies

Wide input voltage isolated DC/DC Converters

Features:
Wide input voltage range (4:1)
Operating temperature range: -40°C to +85°C
Isolation: 1500VDC
Light-load efficiency high up to 78%, ripple & noise as low as 50mV
No-load power consumption as low as 0.12W
Input under-voltage, output short-circuit, over-current and over-voltage protections
Meet CISPR22/EN55022 CLASS A, without external components

UL60950, EN60950 and IEC60950 approval

Figure 6: Wide input voltage isolated DC/DC Converters

Fixed input voltage isolated DC/DC Converters

Features:
Continuous short-circuit protection
Operating temperature range: -40°C to +105°C
Isolation: 3000VDC
Ripple & noise as low as 50mV
High efficiency up to 80%

Figure 7: Fixed input voltage isolated DC/DC Converters

Isolated AC/DC Converters

Features:
Universal input voltage range: 85-264VAC/100-370VDC
Regulated output, low ripple & noise
Isolation: 3000VAC
Output short-circuit, over-current and over–voltage protections
IEC60950, UL60950, EN60950 approval
Plastic case, meeting UL94V-0

Figure 8: Universal input Isolated AC/DC Converters

Gradually large-scale and universal household energy storage is a reasonable developmental trend for the world's energy demand. Actively participating in the development of green energy technology and combining own technology platform with independent innovation capability, MORNSUN provides a complete power solution for the system to simplify its circuit design, reduce costs of household construction and maintenance and improve the system's stability, security and reliability.

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www.mornsun-power.com

Design of Resonant LLC Converters by Cloning

By Prof. Shmuel (Sam) Ben-Yaakov, PELC- Power Electronics Consultancy

Introduction

Resonant LLC converters (RLLCC) are currently very popular and are a preferred design approach due to their multitude advantages such as zero voltage switching (ZVS) and low electromagnetic interference (EMI) as compared to PWM converters. The efficiency of well-designed RLLCC could reach 95% and beyond, and they normally include transformer isolation. Consequently, RLLCC are now being implemented widely and they are very popular in server farms.

The design of RLLCC is complex, since it includes many degrees of freedom and requires extensive engineering experience considering the fact that it is guided by many rules of thumb. The objective of the design is to reduce losses on one hand, and on the other hand to enable a wide load range, without losing regulation. In reality, the ability of the RLLCC to maintain the output voltage at light load is limited and burst operation needs to be invoked. This leads to lower efficiency and extensive noise. In the light of the above, RLLCC design required many simulations runs and a trial and error approach.

In many instances, the RLLCC designer has at its disposal a 'good' design of an RLLCC, either his own, or one of those found in application notes and reference designs offered by practically all pertinent vendors. However, in most cases, the available design does not meet the required design objective in terms of input voltage, output voltage, power level or switching frequency.

This article described a simple method by which a 'good' RLLCC designed can be cloned to meet different requirements without losing the original 'good' featured of the design such as frequency span, load range and high efficiency.

A short video on the subject can be found at:
https://www.youtube.com/watch?v=YGt6p5zr3mg

RLLCC small signal model

Resonant converters, including RLLCC, are based on a resonant network, square wave driver, transformer and rectifier. The driver could be of a full bridge configuration (Figure 1a) or a half bridge form (Figure 1b). Analysis and design of RLLCC are normally done by applying the small signal equivalent circuit (Figure 2) which is based on the first harmonics approximation.

The small signal equivalent circuit of the RLLCC has been used here to develop the transformation rules listed below. The theoretical foundation of the transformation rules is based on the following principles that ensure not only proper operation but the same features as the reference 'good' design. For example, one of the transformation criterium is keeping the quality factor equal to that in the reference design. This implies an identical value for the ratio between the equivalent resistance Rac and the impedances of the inductors. Another criterium is to maintain the inductance ratio constant. This will maintain the voltage gain about constant over a wide load range. Hence, these conversion rules keep the 'good' properties of the original RLLCC even if there is a change in the nominal switching frequency, power level, output voltage or input voltage.

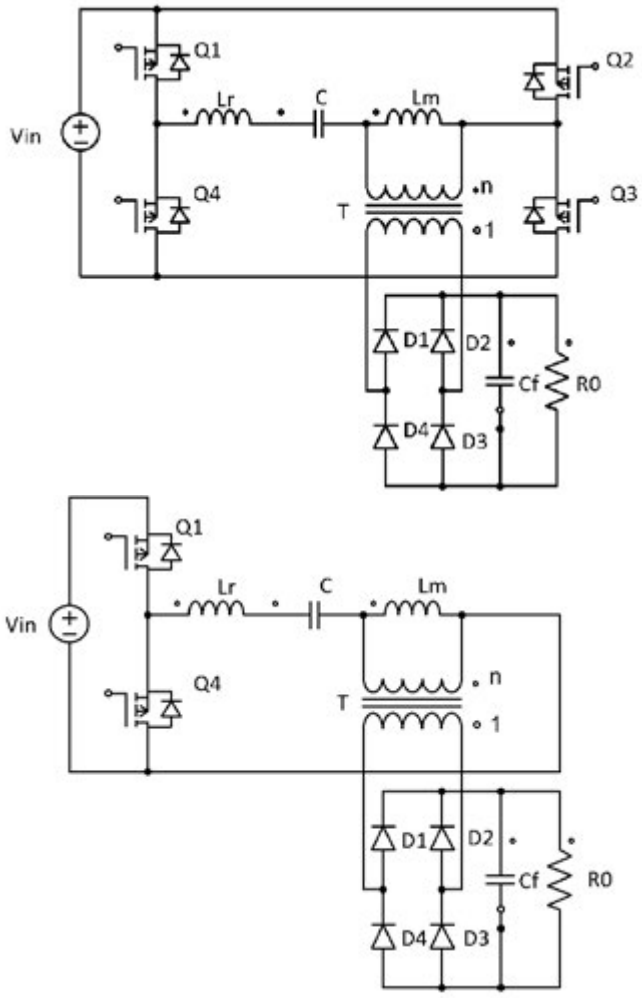


Figure 1: Resonant LLC converter. a. Full bridge configuration. b. Half bridge configuration.

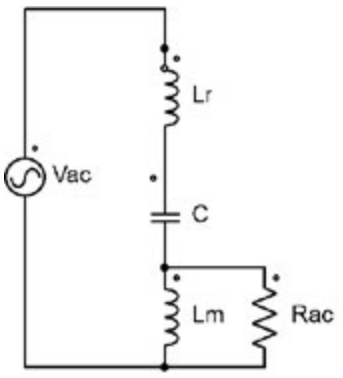


Figure 2: Small signal equivalent circuit of the RLLCC

Rule for cloning when a 'good' RLLCC design is given
The followings are the parameter definitions used below:
Vin = input DC voltage
V_o = output DC voltage
R_o = nominal output (DC)
f = nominal switching frequency
p = nominal output power
Lr = series inductor (see Figure 2)
Lm = parallel inductor (to output)
C = resonant capacitor
n = transformer turns ratio
Index 1 = designates original design (e.g. Vo1)
Index 2 = designates a parameter of desired RLLCC

Change of output DC voltage from Vo1 to Vo2 – power, input voltage and switching frequency are maintained
Since the power is kept the same, nominal output (DC) resistor must be changed from Ro1 to Ro2 and the transformer's turns ratio needs to be altered from n1 to n2

$$R_{02} = R_{01}(\frac{V_{02}}{V_{01}})^2 \qquad n_2 = n_1 \frac{V_{01}}{V_{02}}$$

In this case, there is no need to change the value of the resonant network elements. The change in Ro and n is such that the reflected Rac (Figure 2) is kept the same. So, from the point of view of the small signal equivalent circuit, there is no change.

Change of nominal switching frequency from f1 to f2 – all other parameters are kept the same.
In this case there is a need to change the values of the inductors and capacitor.

$$C_2 = C_1 \frac{f_1}{f_2} \qquad Lm_2 = Lm_1 \frac{f_1}{f_2} \qquad Lr_2 = Lr_1 \frac{f_1}{f_2}$$

The change of the reactive elements keeps the values of the impedances and quality factor as in the reference RLLCC. The inductors ratio also does not change to keep the same behavior as in reference unit.

Change of output power from p1 to p2 - all other parameters are kept constant

$$R_{02} = R_{01}\frac{p_1}{p_2} \qquad C_2 = C_1\frac{P_2}{P_1} \qquad L_{r_2} = L_{r_1}\frac{p_1}{p_2} \qquad L_{m_2} = L_{m_1}\frac{p_1}{p_2}$$

The power change requires a modification of the equivalent Rac resistor. This dictates a change in reactive elements to keep the quality factor constant.

Change of input voltage from Vin1 to Vin2 – all other parameters are kept constant

$$n_2 = n_1\frac{V_{in2}}{V_{in1}} \quad L_2 = L_1(\frac{V_{in_2}}{V_{in_1}})^2 \quad C_2 = C_1(\frac{V_{in_1}}{V_{in_2}})^2 \quad L_{m_2} = L_{m_1}(\frac{V_{in_2}}{V_{in_1}})^2 \quad L_{r_2} = L_{r_1}(\frac{V_{in_2}}{V_{in_1}})^2$$

This conversion rule keeps the same input to output voltage ratio (despite the change in input voltage) and the value of the quality factor.

A change from full bridge to half bridge configuration – all other parameters are kept the same
A change from a full to half bridge is equivalent to a change in input voltage by ½. The rules for a change in input voltage are given above.

Conclusion
A method is presented for changing the components' values of a 'good' RLLCC design such that the cloned RLLCC will meet another set of specifications. This without altering the 'good' behavior of the design. For example, operation from 40V rather than from 400V. It should be pointed out that the cloned RLLCC has the potential of keeping same efficiency as the reference if the components will be chosen to meet the new operating conditions. For example, if the cloned RLLCC is to be operated from a lower input voltage, the current will be higher than in original circuit, and to maintain the efficiency, the inductors resistances should be lower.

Professor Sam Ben-Yaakov (sam.benyaakov@gmail.com) is a researcher and lecturer at the Ben-Gurion University of the Negev, Israel, and serves as a consultant to industry. His areas of expertise are analog electronic circuits and power electronics. He published more than 300 papers in leading professional journals and holds about 25 patents. Prof Ben-Yaakov is a partner in PELC - Power Electronics Consultancy.

www.ee.bgu.ac.il/~pel

www.youtube.com/user/sambenyaakov/videos

SiC Devices Poised and Ready for Harsh Environment Applications

New Wolfspeed module achieves reliability benchmark required for outdoor power conversion systems in renewable energy and transportation.

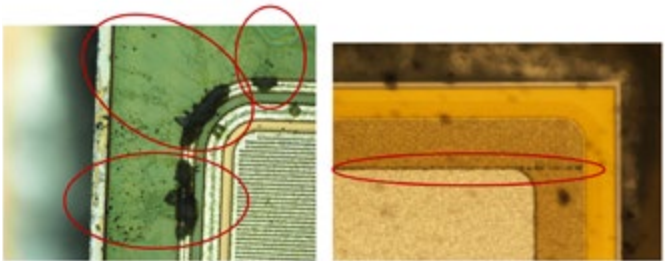
By Guy Moxey, Senior Director, Power Product Marketing & Applications, Wolfspeed, A Cree Company

Introduction

Silicon carbide (SiC) power devices have arrived as a viable alternative to silicon (Si) in applications requiring efficient, high voltage, high frequency power conversion. As expected from the superior materials characteristics, SiC devices have enabled high performance systems that achieve the highest efficiency standards without any compromise of the reliability. Wolfspeed SiC diodes, for example, have been in the field for over a decade, accumulating more than 2 trillion device operational hours with less than one failure per billion hours in primarily industrial (indoor) applications. In recent years, outdoor applications such as renewable energy and transportation have emerged with a need for SiC devices to achieve system size, weight, efficiency, and cost targets. SiC devices have delivered on the price-performance expectation, but initial outdoor field deployments demonstrated some challenges which are shared by all semiconductor devices while operating under high humidity conditions.

The Humidity Problem

The presence of moisture under bias has been a historical issue for all electronics. Semiconductors such as conventional Si power devices introduce the added complexity of higher voltages present at the exposed chip surfaces as well as materials and active regions that are sensitive to humidity-induced degradation. The ultimate failure mode is a loss of high voltage blocking capability with typical failure mechanisms associated with electro-chemical migration, extended corrosion, and mobile ions [1]. These challenges in Si power devices are exacerbated with SiC due to the catalyzing effects of the order of magnitude larger electric fields, further exciting the aforementioned failure mechanisms (Figure 1). Wolfspeed engineers have invested considerable time and resources to develop the new W-series module products bearing process and design solutions that address all of these historically observed semiconductor failure mechanisms.



Wolfspeed Figure 1: Higher voltages present at the exposed chip surfaces

A New Qualification Testing Standard

The standard JEDEC qualification test for industrial modules has been high humidity, high temperature reverse bias (H3TRB), also known as temperature and humidity bias (THB). This test occurs in an environmental chamber set to 85% relative humidity and 85°C. The devices under test (DUTs) are placed in this chamber under 100V bias and stressed for 1000 hours. Passing the test requires all DUTs to remain within datasheet specifications and minimal amount of parametric shift (20% for voltage measurements and 1000% for leakage measurements) [2]. The H3TRB test was found to be ineffective in predicting success for outdoor applications because devices were subject to voltages significantly higher than 100V.

A new humidity test was developed from the Si power device community—high voltage H3TRB (HV-H3TRB)—where the bias voltage was simply increased to reflect the maximum use condition of 80% rated blocking voltage. Hence, this test is also known as THB-80. For example, 1200V devices which were previously tested at a mere 100V would now be tested at 960V which is a typical use voltage in the higher voltage applications. From the Si experience, devices successfully operating in the field under high humidity conditions have passed HV-H3TRB qualification at 1000h and ultimately fail above 2000h. Wolfspeed's WAS300M12BM2 (1200V, 300A half-bridge module in the 62mm package shown in Figure 2) is the first All-SiC module to achieve this new reliability benchmark.

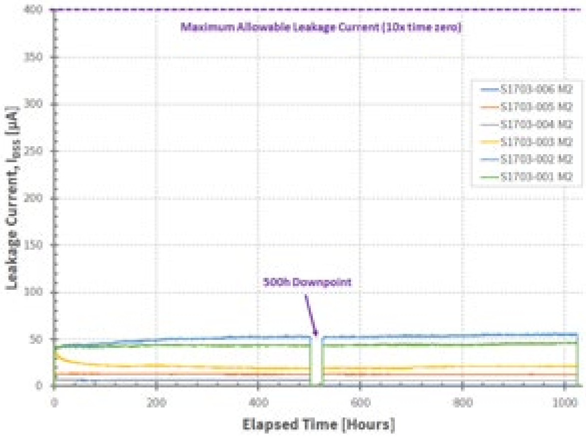
Wolfspeed Figure 2: First All-SiC module to achieve this new reliability benchmark

An All-SiC Power Module for Harsh Environments

The WAS300M12BM2 module is powered by the new Wolfspeed MOSFETs (CPM2-1200-0025A) and Gen5 Schottky diodes that also achieve the harsh environment benchmark at the die level. In qualifying the bare die, 25 DUTs from 3 different assembly batches (a total of 75 MOSFET DUTs and 75 Schottky DUTs) successfully passed the HV-H3TRB test to establish statistical significance and run-to-run repeatability. Electrically identical to the existing industrial CAS300M12BM2 module, the new harsh environment WAS300M12BM2 module retains the low 4.2 mΩ on-resistance and more than five times lower switching losses than similarly rated, latest generation IGBT modules. Module construction utilizes high thermal conductivity aluminum nitride substrates and optimized assembly methods to meet industry thermal and power cycling requirements.

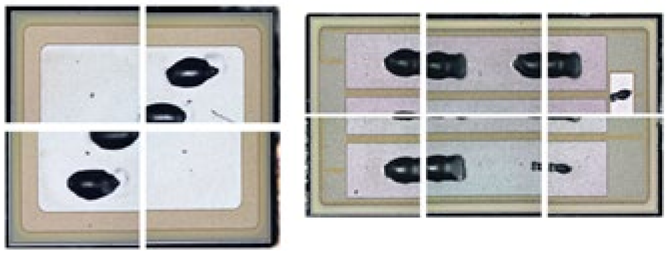
A random sampling of 6 WAS300M12BM2 modules were subjected to the HV-H3TRB test. At the conclusion of each 500h iteration, all DUTs were removed from the chamber and tested for electrical stabil-

ity and datasheet compliance. One module was sacrificed for visual inspection at 500h and at 1000h to make sure that there were not any lurking defects that could lead to early failure.



Wolfspeed Figure 3: Devices monitored for leakage current

In addition to the normal monitoring to ensure HV-H3TRB conditions, each of the DUTs were individually monitored for leakage current (IDSS). Unstable IDSS waveforms have been known to be pre-cursors to catastrophic failures. As shown in Figure 3, all DUTs demonstrate stable IDSS waveforms throughout the 1000h of qualification. Electrical testing confirmed datasheet compliance with <5% voltage shift and <50% leakage shift, both well within allowable JEDEC shift criteria. Visual inspection of the sacrificed modules at 500h and 1000h show pristine die surfaces, comparable to un-stressed parts (Figure 4). High magnification microscopy confirms no evidence of the oxidation and electro-chemical migration failure modes. The four remaining un-opened modules continue to run under HV-H3TRB testing without failure after 2000+ hours.



Wolfspeed Figure 4: Visual inspection of the sacrificed modules at 500h and 1000h show pristine die surfaces

Conclusion

The new Wolfspeed WAS300M12BM2 power module demonstrates excellent performance under high humidity conditions. This is the first All-SiC power device to be qualified for harsh environment use by clearly demonstrating electrically stable, long-lifetime performance under HV-H3TRB without any lurking issues observed in the post stress physical analysis. These results literally and figuratively open the door for using Wolfspeed's W-series devices in key outdoor power conversion applications such as renewable energy and transportation where SiC performance is valued.

References

[1] C. Zorn, M. Piton, N. Kaminski, "Impact of Humidity on Railway Converters," Proceedings of PCIM 2017, pp. 715-722.

[2] Information located at website: http://www.jedec.org

www.wolfspeed.com

Quad DMOS Full-Bridge PWM Motor Driver IC

Allegro MicroSystems Europe introduces a quad DMOS full-bridge driver IC capable of driving up to two stepper motors or four DC motors. Each full-bridge output is rated up to 1.6 A and 40 V. Allegro's A5990 includes fixed off-time pulse-width modulation (PWM) current regulators, along with 2- bit nonlinear DACs (digital-to-analog converters) that allow stepper motors to be controlled in full, half, and quarter steps, and DC motors in forward, reverse, and coast modes. High resolution microstepping control is possible via independent current control reference voltage inputs for each full bridge.

www.allegromicro.com

Valuable Extension to 'HiT', High Temperature MLCC, Range

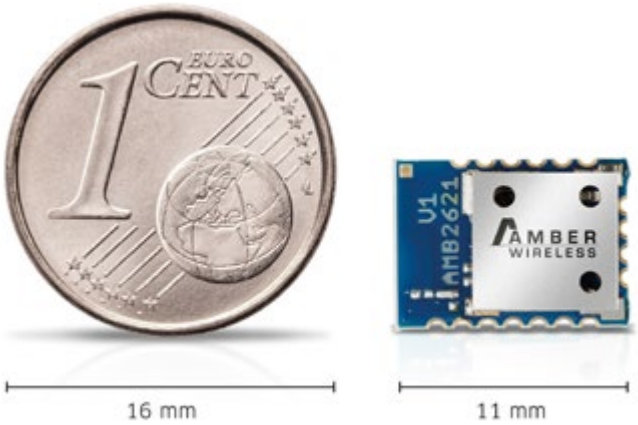
One year on from the initial launch of a new range of high temperature MLC chip capacitors, Knowles capacitor brands Novacap and Syfer Technology have jointly announced a significant extension to the product offering. As with the initial launch, this announcement coincided with another IMAPS event – the HiTEN 2017 symposium in Cambridge UK. The Knowles Capacitors HiT range of MLCCs has an operating temperature range of -55 to +200ºC. The range offers tin over nickel terminations that had not been previously available in the company's other high temperature MLCC ranges.

Launch specifications encompassed both Stable (C0G) and ultra stable (X7R) dielectric options in case sizes 0805 to 2220, with capacitance spread of 4.7pF to 3.3uF and rated voltages of 16 to 630V dc. To be announced at HiTEN 2017 is the increase in specified max capacitor values for the 500/630V parts – upper limit now 68nF – and the addition of an 0603 case size in X7R material (C0G being hot on the heels). This range, both RoSH compliant and lead free, is manufactured to exacting standards using Knowles unique screen printing process to provide a high quality component suitable for demanding applications. Projects in oil exploration, geothermal, military, automotive under-hood and avionics will find the wide capacitance range of interest.

www.knowlescapacitors.com

Integrating Bonding Function in AMB2621 Bluetooth Smart Module

AmbeR wireless GmbH expands the functionality of its AMB2621 Bluetooth Smart Module: The packet size for payload data transmission is raised from 128 to 243 bytes. Additionally, the extremely compact and energy-saving wireless module now has a bonding option.



In use, this allows the pairing key to be stored securely in the module and a new connection with the device equipped with AMB2621 can be established without re-authentication.

AMB2621 is a 2.4 GHz wireless module compliant with the Bluetooth Smart 4.2 standard and is available with or without an integrated antenna. As a special feature for the industrial wireless module domain, AMB2621 also offers the 'peripheral only' operating mode. This even allows pairing to be initiated from a smartphone, as the device in which the AMBER wireless module is integrated provides a BLE (Bluetooth Low Energy) connection. The manufacturer has now advanced a method from consumer electronics, whereby the wireless module stores the key of the remote terminal and renders pairing permanent. This 'bonding' means the user only needs to enter a key with the first connection.

Thanks to the 'peripheral only' operating mode, the AMB2621 Bluetooth Smart module is especially energy-saving. The UART interface (Universal Asynchronous Receiver Transmitter) is only active once a wireless connection is established.

www.amber-wireless.de

250V Ultra-Junction X3-Class Power MOSFETs

IXYS announced a power semiconductor product line: 250V Ultra-Junction X3-Class HiPerFET™ Power MOSFETs. With on-resistances and gate charges as low as 4.5 milliohms and 21 nanocoulombs, respectively, these devices enable highest power densities and energy efficiencies in a wide variety of high-speed power conversion applications.

Developed using a charge compensation principle and proprietary process technology, the new MOSFETs provide the best-in-class Figure of Merit (on-resistance times gate charge) which translates into lowest conduction and switching losses. They exhibit the lowest on-state resistances in the industry (5 milliohms in the TO-264 package and 4.5 milliohms in the SOT-227, for instance).

www.ixys.com

Multifuse® Ultra-Low Resistance Surface Mount PPTC Resettable Fuses

PPTC models provide optimal circuit protection performance for a wide variety of space-constrained portable electronics applications

All the new Multifuse® models are based on Bourns› freeXpansion™ technology, which is a space-saving manufacturing process that enables smaller surface mount package sizes, while also making it possible for Multifuse® devices to handle larger currents and voltages with improved resistance stability. “The ultra-low resistance, small footprint, and low profile all make our latest Multifuse® product series ideal protection solutions for a new generation of space-constrained portable devices including smartphones, tablets, wireless headphones, PC motherboards, USB drives and gaming consoles,» said Lee Bourns, Multifuse Product Line Manager at Bourns, Inc. “And because these devices are based on Bourns’ freeXpansion™ technology, they offer superior current, voltage and resistance performance over traditional PTC solutions for designs that require more advanced overcurrent and overtemperature protection.”

www.bourns.com

Automotive, Half-Bridge MOSFET Driver ICs

Allegro MicroSystems Europe has announced two N-channel power MOSFET driver ICs capable of controlling MOSFETs connected in a half-bridge arrangement. Allegro's A4926 and A4927 are specifically designed for automotive applications with high-power inductive loads,

such as, DC Pumps (Braking, Oil, Water, and Fuel), HVAC (Blower Fan), solenoids, and actuators. These devices are intended for automotive systems that must meet ASIL requirements. In common with other Allegro A2SIL™ products, this device incorporates features to complement proper system design, allowing users to achieve the required ASIL level.

A unique charge pump regulator provides full gate drive for battery voltages down to 5.5 V for most applications. A bootstrap capacitor, with optional bootstrap management, is used to provide the above battery supply voltage required for N-channel MOSFETs. The half-bridge can be controlled by independent logic-level inputs or through the SPI-compatible serial interface. The external power MOSFETs are

protected from shoot-through by a programmable dead time. Integrated diagnostics provide indication of multiple internal faults, system faults, and power bridge faults, and can be configured to protect the power MOSFETs under most short-circuit conditions.

www.allegromicro.com

Single-Chip Buck-Boost Battery Charge Controllers

Texas Instruments introduced a pair of highly flexible, single-chip buck-boost battery charge controllers for one- to four-cell (1S to 4S) designs. The bq25703A and bq25700A synchronous charge controllers support efficient charging through USB Type-C and other USB ports in end equipment ranging from notebooks and tablets to power banks, drones and smart home applications.

Supporting both I2C and SMBus interfaces, the bq25703Aand bq25700A feature a new advanced battery algorithm enabling full power output by adding intelligence to battery charging through maximum power point tracking technology. The unique algorithm, referred to as input current optimization (ICO), automatically detects the full capacity of input power to optimize current, while maintaining consistent system and charging current to ensure the utilization of maximum input power.

www.ti.com/bq25703A-pr-eu

www.ti.com/bq25700A-pr-eu

Special Capacitors for Wind Power

FTCAP is presenting moisture-proof capacitors as part of its appearance at HUSUM Wind.

Everything revolves around wind energy at HUSUM Wind from 12 to 15 September 2017 – and FTCAP is also focussing on capacitors that are ideally suited for use in wind power plants. In addition to the moisture-proof capacitors and proven electrolytic capacitor banks from the Husum-based company, visitors will also be impressed by the high-performance PowerStack developed by FTCAP together with partners in the scope of a research project.

The foil capacitors with special aluminium encapsulation could be a small revolution for wind power plant operators. “Air humidity is a major problem in offshore wind parks, in particular, because standard capacitors are very sensitive to moisture and salty air,” explained André Tausche, Managing Director of FTCAP. “Therefore, we have developed foil capacitors that are very well-protected from moisture, thanks to their special encapsulation.” As a result, the surface corroded by the moisture is limited to the isolation required outside of the capacitor. With their axial design provides anti-rotation protection in order to minimise stress from torque at the sensitive transition from the terminal to the capacitor foil.

The proven electrolytic capacitor banks from FTCAP are well-suited for use in wind power plants, thanks to their robust construction. With these solutions, several capacitors can be connected to a single bus bar connection and permanently grouted with polyurethane in a sturdy plastic housing. The closed system makes it practically impossible for moisture to penetrate, which significantly extends the service even in harsh conditions, such as offshore.

Visitors to HUSUM Wind will also be impressed with the high-performance PowerStacks that FTCAP has developed together with partners Mersen and AgileSwitch. These systems combine power modules, bus bars, capacitors, cooling devices and gate drivers in a single unit with high power density. FTCAP exhibit at Husum Wind is at stand 5B24.

www.ftcap.de

Product Innovations Target Voiding Issues

Alpha Assembly Solutions, the world leader in the production of electronic soldering and bonding materials, addresses the issue of voiding with its latest selection of advanced product technologies.

Voiding is a common issue in PCB Assembly and is caused by volatile ingredients in the solder paste. Voiding can occur anywhere in the solder joint and is especially problematic as it reduces the mechanical properties and thermal conductivity of solder joints.

To solve this issue, Alpha has developed the revolutionary ALPHA® AccuFlux™ Technology for preforms. The flux coating when applied to a preform is engineered to decrease voiding for power components that require consistent low-voiding solder joints from normal SMT processes.

"ALPHA® AccuFlux™ Technology allows a specially designed coating with an ultra-low voiding flux formulation to be applied accurately from preform to preform," explains Mike Marczi, Vice President of Engineered Materials at Alpha Assembly Solutions, a part of the MacDermid Performance Solutions Group of Businesses. "This precise flux deposit ensures a repeatable void performance. Preforms coated with AccuFlux™ also deliver excellent electrical reliability and maximized component heat dissipation."

www.AlphaAssembly.com

The Complete Future Soldier Communications Solution

TT Electronics has long manufactured a range of fully RoHs complaint Vdmos packages, dedicated to the robust and severe environments seen in military communications. The range offers 12.5 V, 28 V and 50 V operation, and two cell sizes – 2.5 W and 20 W.

The excellent matching of the chips enables us to combine die to give us a range from 1 W up to 350 W, thus providing the same technology from drivers to full power output in a wide range of industry standard package options. TT Electronics is proud to say that this range is now over 30 years old, and yet no product has become obsolete. In addition, TT Electronics is able to offer suitable alternatives to other leading manufacturer's devices whilst offering replacements with little or no circuit or mechanical changes.

Whilst soldier communications play a key role in modern warfare, comms systems on board fighting vehicles are also a critical requirement. In this field, TT Power Electronics is able to offer expertise in technologies such as power and filtration systems, providing a one-stop shop for any discerning customer in the military arena.

Our range of technologies designed to provide the future soldier with highly reliable communications systems can be explored at DSEI in September at our booth, S5-260.

Download for RF Brochure: http://www.ttelectronics.com/sites/default/files/download-files/TT%20RF.pdf

Download for Cross Reference: http://www.ttelectronics.com/semiconductors/rf/manufacturer-cross-reference]

www.ttelectronics.com

Introduction of Advatage Substrates Family

Rogers Corporation's Power Electronics Solutions (PES) group has announced the availability of curamik® ADVANTAGE, a family of features and process enhancements for its high-power curamik® ceramic circuit substrate materials. The materials enable circuit designers to optimize the performance of their high-power circuits through a wide assortment of services and processes, including several plating options for improved copper surface finish, two different treatments for minimizing PCB surface roughness, selective etching, precise laser drilling of small-diameter through holes, addition of solder stop to prevent solder bridging, and optimization for advanced silver sintering process that offers an alternative to conventional solder device attachment. High-voltage curamik ceramic-based circuit materials include curamik Power, curamik Power Plus, curamik Performance, and curamik Thermal, offering a broad range of thermal conductivities from 24 to 170 W/m-K. The materials are especially formulated to effectively disperse heat in power electronics circuits with heat-generating, high-power active devices, such as IGBTs and MOSFETS. The curamik ADVANTAGE family of processes and services enhances both the usability and performance of the curamik materials, improving reliability in the process.

www.rogerscorp.com/pes/design/index.aspx

ESD-Clamping Diodes in 0201 Package

Miniature (0201-size) single-line ESD-protection diodes from STMicroelectronics quickly clamp transients to a voltage as low as 7V, and handle 7A peak pulse current, to provide superior protection and design flexibility for space-constrained smart objects. This diode drops the bar with the lowest clamping voltage available at this level of capacitance and stand-off voltage.

The unidirectional ESDZL5-1F4 and bidirectional ESDZV5-1BF4 have a snap-back characteristic, with 5.8V trigger voltage and low dynamic resistance, to provide outstanding protection in a device measuring only 0.58mm x 0.28mm (typical). Also, with as little as 6pF capacitance, they ensure the integrity of high-speed signals. Capable of withstanding 15kV and 18kV contact discharge respectively, both devices exceed the IEC 61000-4-2 specifications.

With leakage current below 100nA helping to maximize battery life, ST's new ESD-clamping diodes are ideal for protecting equipment such as industrial sensors, IoT devices, active cables and connectors, smart-home electronics, wearable devices like smart watches and healthcare or fitness bands, and portable products including smartphones, tablets, data loggers, and point-of-sale terminals.

www.st.com/esd-protection-zseries-news

Low Cost TRIAC Dimmable Drivers

RECOM introduces four new LED drivers with 9W, 12W, 18W and 25W outputs. They deliver 1% to 100% leading-edge or trailing-edge TRIAC-controlled dimming at the market's most affordable prices. These LED drivers are designed for either retrofit or new installations and allow the user to set the lighting atmosphere and mood in homes, spotlighting and furniture installations.

The new RACT series are low cost, triac-dimmable LED drivers available with constant current outputs ranging from 300mA up to 1400mA. Both leading and trailing edge phase angle control makes them suitable for many standard dimmers for a wide range of applications. The RACT series are ideal for indoor locations up to 50°C ambient temperature and are certified for building into furniture for applications such as dimmable shelf lighting, cove lighting or accent lighting. Integrated cable clamps and extra-large screw terminals make for an easy installation. The Class II (double insulated) design means that no earth connection is required. They are CE marked (LVD + EMC + RoHS) and have IEC61347-1/IEC61347-2-13 CB reports. RECOM offers a 3 year warranty as standard. Samples are available from all authorized distributors.

www.recom-power.com

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High-quality products for industrial applications.

ABB is a world's leading suppliers of high-power semiconductors, setting standards for quality and performance. Our unique knowledge in the field now expands to industry standard medium-power IGBT. The 62Pak phase leg IGBT modules, featuring 1700 V voltage are designed for low-loss, high performance and the best in class operating temperature capability of up to 175 °C for the most demanding medium-power applications.

abb.com/semiconductors

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SEMICON® EUROPA

14 - 17 Nov 2017, Messe München, Munich, Germany

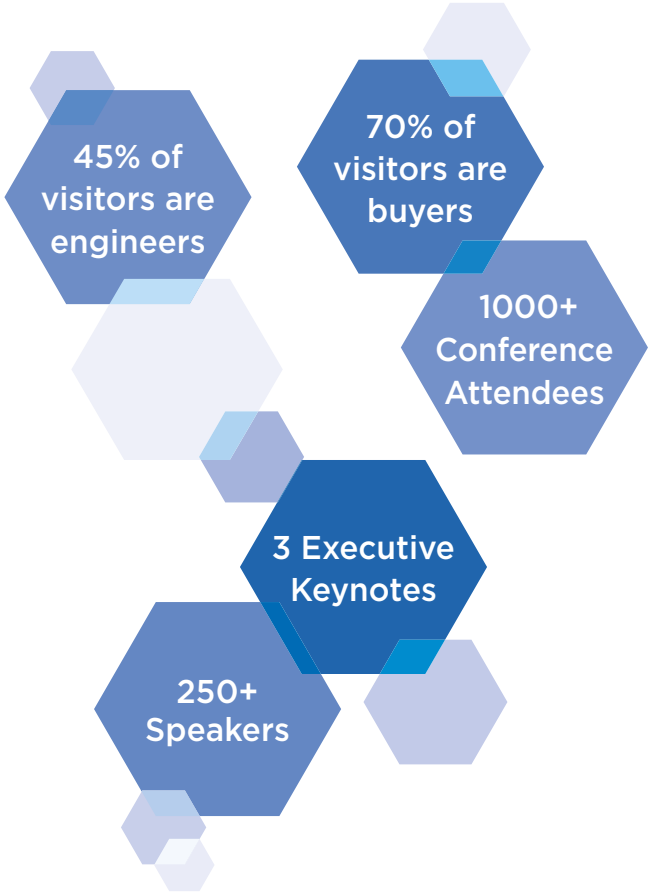
SEMICON Europa 2017:
Empowering Innovation and Shaping the Value Chain

For the first time SEMICON Europa will co-locate with productronica in Munich, Germany creating the strongest single event for electronics manufacturing in Europe, and broadening the range of attendees across the electronics supply chain. The co-location with productronica embodies the SEMI global strategy to connect the breadth of the entire electronics supply chain.

SEMICON Europa events will expand attendee opportunities to exchange ideas and promote technological progress featuring the most advanced and innovative electronics manufacturing platform in Europe.

Convenient and central location in Europe, Munich will attract tens of thousands of international visitors: Together to connect for electronics business!

Key Segments at SEMICON Europa 2017: Materials, Semiconductor Front-end and Back-end Manufacturing, Advanced Packaging, MEMS/Sensors, Power and Flexible Electronics, applications such as the Internet of Things (IoT), automotive and MedTech.



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Extended Range of PTC Inrush Current Limiters

TDK Corporation has extended its range of EPCOS PTC-based inrush current limiters. The four new versions of the B5921*J0130A020 series with plastic housing are designed for voltages from 280 V AC to 560 V AC, offer rated resistances from 22 Ω to 100 Ω at 25 °C and have a heat capacity of up to 2.3 J/K. They are UL approved and are qualified to AEC-Q200.

The B594* and B597* series of leaded disk components offer rated voltages of between 260 V AC and 560 V AC. Depending on the type, their rated resistances are between 25 Ω and 1100 Ω. Also type-dependent, these protection devices have been approved in accordance with UL, IECQ and VDE. All types of both series are RoHS-compatible. One great advantage of PTC inrush current limiters is their intrinsic safety. For example, if a short circuit should occur within a device when it is switched on, the component very quickly limits the current to non-critical values. Typical applications for PTC inrush current limiters include converters and power supplies for industrial and household electronics as well as in e-mobility applications. These include onboard charging circuits and the charging and discharging of DC link capacitors in the drives of hybrid and electric vehicles.

www.epcos.com/ptc_icl

Liquid Soldering Flux for PV Tabbing & Stringing Applications

Alpha Assembly Solutions, the world leader in the production of electronic soldering and bonding materials, is introducing ALPHA® PV-38i, its newest liquid soldering flux for PV Tabbing and Stringing.

ALPHA® PV-38i is a zero-rosin, no-clean flux specifically designed to meet the demanding requirements of the photovoltaic industry. This tabbing and stringing flux has the lowest solids formula (1.10%) available in the industry.

"ALPHA® PV-38i employs a unique proprietary activator system that limits pollution inside tabbing and stringing equipment and spray nozzles, with practically zero residue present after soldering", said Mike Previti, Global Product Manager for Flux at Alpha Assembly Solutions, a part of the MacDermid Performance Solutions Group of Businesses. "This formula also allows an extended shelf life versus many other competitive fluxes in the industry".

In addition, the unique chemistry of ALPHA® PV-38i provides excellent soldering with fast wetting in standard module assembly processes, employing widely used methods (preheat and soldering) for both spray on cell or dip applications.

www.AlphaAssembly.com

OptiMOS™ Linear FET combines a low RDS(on) with a Large Safe Operating Area

Infineon Technologies AG launches the OptiMOS™ Linear FET series. This new product family combines the state-of-the-art on-state resistance (R DS(on)) of a trench MOSFET with the wide Safe Operating Area of a planar MOSFET. This solves the trade-off between R DS(on) and linear mode capability. The OptiMOS Linear FET can operate in the saturation region of an enhanced mode MOSFET. It is the perfect fit for hot-swap, e-fuse, and protection applications commonly found in telecom and battery management systems (BMS).

Both, the rugged linear mode operation and the higher pulse current contribute to low conduction losses, faster start-up, and shorter down time. The OptiMOS Linear FET prevents damage at the load if there is a short circuit, by limiting high in-rush currents. The OptiMOS Linear FET is available now in three voltage classes: 100 V, 150 V, and 200 V. They can be supplied in either a D²PAK or D²PAK 7pin package. These industry standard packages offer a compatible footprint for drop-in replacement. More information is available at

www.infineon.com/optimos-linearfet

Stocking Cree's Next-Generation XLamp XHP70.2 LEDs

Mouser Electronics, Inc., the industry's leading New Product Introduction (NPI) distributor with the widest selection of semiconductors and electronic components, is now stocking the XLamp® XHP70.2 LEDs from Cree. These second-generation Extreme High Power (XHP) LEDs deliver up to 9 percent more lumens and 18 percent higher lumens-per-watt (LPW) than the first-generation XHP70 LEDs.

The Cree XLamp XHP70.2 LEDs, available from Mouser Electronics, feature the same 7.0 mm × 7.0 mm footprint as the previous generation and provide an easy drop-in upgrade for customers with existing XHP70 designs. The LEDs provide a wide viewing angle of 125 degrees and up to 58 percent higher lumen density than the closest LED of the same size, enabling smaller luminaires and better optical control for high-lumen lighting applications.

The XHP70.2 LEDs are available from Mouser Electronics in ANSI White and Cree's 2-step, 3-step, and 5-step EasyWhite® correlated color temperatures (CCTs) ranging from 3000K to 5700K with high color rendering index (CRI) ratings options. The LEDs are configurable to 6 V/4800 mA or 12 V/2400 mA and are binned at 85 degrees Celsius.

www.mouser.com/new/cree/cree-xlamp-xhp70-2

Magnetics Transformers Meet PoE, PoE+ and UPoE Power Specs

Premier Magnetics, global producer of high-quality magnetic components, introduces its expanded line of low-cost, high-performance transformers designed to support the full range of Power-over-Ethernet (PoE) applications from IEEE 802.3af (15.4W, max), IEEE 802.3at (30W), Cisco UPoE and other higher-power PoE extensions up to 60W. The low-profile, surface-mount devices operate over a wide frequency range, provide high isolation (1500V) and are available in forward and flyback topologies. These transformers are designed for use with power management integrated circuits (PMICs) from major manufacturers including Akros Silicon, Texas Instruments and Broadcom for application in both Power Sourcing Equipment (PSE) and PoE Powered Devices (PD). In addition, many of these parts are direct cross-reference with Pulse Electronics and CoilCraft devices. Premier Magnetics PoE transformers are offered in two series: the EP Series (3W-27W) and the EFD15 Series (1W to 60W). In addition to an extensive range of standard parts, custom designs are also available for each series.

www.premiermag.com

20% Slimmer 1W Surface-Mount Isolated Converter

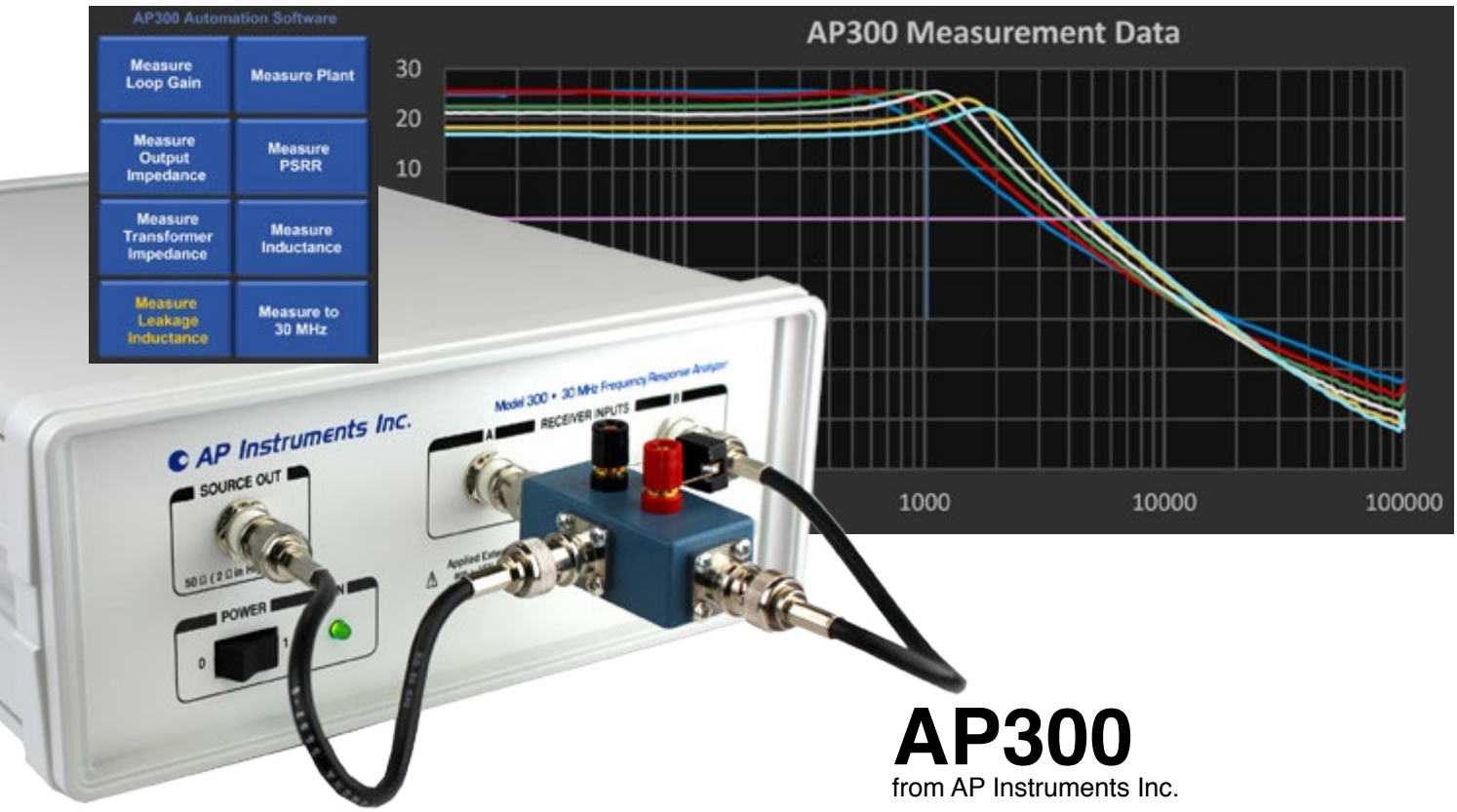
At 20% Slimmer 1W Surface-Mount Isolated Converter converters, available now at Dengrove Electronic Components, are 20% slimmer than alternative converters, and are conveniently packaged as compact, 12.75mm x 10.8mm, surface-mount, open-frame modules.

In addition to satisfying EN 55022/024 and IEC/UL/EN 60950-1, the modules are certified to the incoming IEC/UL/EN 62368-1 safety specification. IEC 62368-1 introduces a new hazard-based approach to safety engineering that gives designers extra flexibility to demonstrate compliance, and is expected to replace the established IEC 60950-1 rules.

R1SX converters can drive capacitive loads of up to 2200µF, which is 40 times higher than comparable alternatives. By also offering 1kVDC or 3kVDC isolation-voltage options, this series presents an ideal solution for isolating CAN-bus connections to ensure equipment safety and preserve signal integrity. They can also be used to power loads in equipment such as industrial automation controllers, without derating, over the full -40°C to 100°C temperature range.

Variants are available with 3.3V or 5V inputs, and a single unregulated 3.3V or 5V output. Capable of operating at up to 78% efficiency, they also have quiescent consumption of less than 150mW thereby minimising dissipation and easing system thermal management. By adopting an industry-standard pinout, R1SX modules provide a drop-in replacement for the R1S series, with 50% lower mounted height. Class A EMC compliance can be reached without external inductors, and only a simple external filter is needed to achieve Class B compliance.

www.dengrove.com



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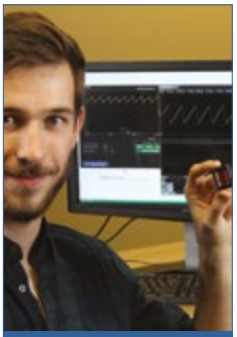
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Optimized Tape Wound Toroidal and Tape Wound Cut Cores

Frank Raneiro, President of Magnetic Metals Corporation, announced the Company will focus on supplying the magnetic components required by today's sophisticated electronics applications. Magnetic Metals' tape wound toroidal cores and tape wound cut cores are at the heart of the most advanced power and navigation systems used in aerospace and defense, transformers and GFCI's for electric vehicles and EV charging stations, power supplies for MRI machines and heart monitors, and voltage measuring/monitoring devices used by electrical utilities.

"In order to optimize our resources to meet our customers' needs, we will expand product production and value-added services at our Anaheim, California facility," Mr. Raneiro reports. "By modernizing and automating our processes we will continue to provide the highest quality magnetic components that have met our customers' most stringent specifications and application requirements for over 75 years."

Additionally, Magnetic Metals is unique in the industry for carrying many types and thicknesses of soft magnetic materials with the most advanced magnetic properties and performance characteristics. These include Nanocrystalline Alloy, Amorphous Alloy, high-permeability/low distortion nickel alloy and cobalt iron, Supermendur™, Microsil™ (grain-oriented silicon steel), SuperPerm™ 80, and Supermalloy™.

www.MagneticMetals.com

SiC MOSFET Technology Enables Power Supplies To Achieve 80+ Titanium Efficiency

Wolfspeed, A Cree Company, has advanced the development of high efficiency data center power supplies through the implementation of an innovative totem-pole PFC topology that employs its latest low-inductance SiC MOSFETs to exceed an 80+ Titanium rating, which is critical for reducing the overall power consumption for data centers, estimated to be more than 70 billion kWh annually in the US.

High-efficiency power supply designs like those employing Wolfspeed's SiC MOSFETs are vital for data center designers as they strive to meet demanding efficiency standards without increasing costs. According to a 2016 US Department of Energy supported study1 on US data center energy usage, efficiency improvements in data center power systems have contributed to an estimated 620 billion kWh in energy savings from 2010 to 2020.

Wolfspeed recently developed a comprehensive reference design that demonstrates the implementation of a totem-pole PFC topology in a 2kW bridgeless power supply that is capable of easily exceeding the 80+ Titanium standards, with actual results of 98.7% peak efficiency at half load and 98.55% efficiency at full load – both taken at 230V redundant operation. Power supply design engineers have faced significant challenges in attaining these efficiency levels using conventional silicon switching devices due to their higher losses and the need for more complex topologies.

The resulting reference design was presented in a webinar entitled "Achieving High Efficiency Power Supplies (80+Titanium) Without Increasing Complexity or Cost," presented by Wolfspeed engineers Dr. Adam Barkley and Edgar Ayerbe, available here: http://www.globalspec.com/events/eventdetails?eventid=1506&evtsrc=ws-release.

1 2016 United States Data Center Energy Usage Report, Lawrence Berkeley National Laboratory, LBNL-1005775

http://www.wolfspeed.com/power/products

Charge Cell Phones to Laptops Simultaneously

Efficient Power Conversion Corporation (EPC) announces the availability of a complete class 4 wireless power charging kit, the EPC9120. The system can transmit up to 33 W while operating at 6.78 MHz (the lowest ISM band). The purpose of this demonstration kit is to simplify the evaluation process of using eGaN FETs for highly efficient wireless power transfer. The EPC9120 utilizes the high frequency switching capability of EPC gallium nitride transistors to facilitate wireless power systems with full power efficiency between 80% and 90% under various operating conditions.

The EPC9120 wireless power system consists of four boards: Source Board (Transmitter or Power Amplifier) EPC9512; Class 4 Air Fuel compliant Source Coil (Transmit Coil); Category 4 AirFuel compliant Device Coil with rectifier and DC smoothing capacitor; Category 3 AirFuel compliant Device Coil with rectifier and DC smoothing capacitor. The popularity of highly resonant wireless power transfer is increasing rapidly, particularly for applications targeting portable device charging. The end applications are varied and evolving quickly from cell phone charging, to handheld tablets, and laptop computers. Delivering up to 33 W supports all of these applications. Source (Amplifier) Board The source board is a highly efficient Zero Voltage Switching (ZVS), Class-D amplifier configured in an optional half-bridge topology (for single-ended configuration) or default full-bridge topology (for differential configuration), and includes the gate driver(s), oscillator, and feedback controller for the pre-regulator. This allows for compliance testing operating to the AirFuel class 4 standard over a wide load range. This amplifier board is available separately as EPC9512 for evaluation in existing customer systems.

www.epc-co.com

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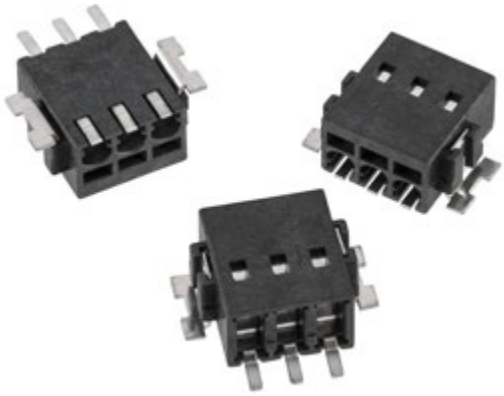
Small, Black and Snappy

Würth Elektronik eiSos offers an addition to its “Wire Protection System WR-TBL” product family: Series 8050 is a horizontal entry clamp in 2.5-mm pitch, available either as a two or three-pole version. What makes this component unique is its combination of properties: perfect for pure SMT assembly without drilling, extremely small (5 mm high) and these parts have screwless spring clamping. WR-TBL 8050 accepts wires from 0.129 to 0.518 mm2 (AWG 26 to 20) and withstands up to 300 VAC. The operating current is 3 A (cULus approved) or 5 A (UL approved) and the working temperature extends from -45 to +120°C.



The WR-TBL 8050 SMT terminal blocks are available from stock. Free samples can be ordered immediately. Further information at

http://ow.ly/X3YG30duCGE

www.we-online.com

Input Rectifiers with Superior Commutation Ruggedness for Power Management

IXYS Corporation, a leader in power semiconductor and IC technologies for energy efficient products used in power conversion and motor control applications, announces today the expansion of its portfolio with a new Input Rectifier technology that combines high electrical performance and high dynamic ruggedness. High performance rectifiers, above the 1000V range, utilizing highly reliable planar proprietary technology have been core to IXYS' worldwide leadership in bipolar power products.

IXYS now offers a new range of standard rectifier diodes with extremely high ruggedness to resist single dynamic events as well as continuous stress. One of the first products is the DMA50P1600HB, a diode phase-leg in a TO-247 package, with a reverse voltage of 1600V and a current rating of 50 Amps. Compared to the predecessor DSP45, the new input rectifier diode has a reduced forward voltage drop, better thermal conductivity and increased current surge capability by over 20%. This unique performance advantage is demonstrated during the commutation conditions in the input sections of AC line powered products.

www.ixys.com

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abb.com/semiconductors

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